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Telephonic Green Goods.

The daily press of New York serves up interesting tales from time to time of the easy way in which a bucolic visitor has been separated from his roll by the green-goods man. The metropolitan citizen smiles pleasantly at these tales and thanks his stars he is living close enough to Broadway to understand such little games. And yet he easily swallows the same bait when it is presented in another guise, as is shown by the present proceedings in the New York telephone situation. The New York Telephone Co. is giving a service that is acknowledged to be the finest in the world. After a complete examination of its books by the Audit Co. and an investigation of its equipment by Westinghouse, Church, Kerr & Co., the Merchants' Association of New York reported recently that "the existing telephone conditions in this city are equitable, both to the public and to the company, and no benefit can accrue to the public through an attempt to modify those conditions by means of competition, but, on the contrary, much harm may be done by such attempt." It should be added, that the Merchants' Association is a chronic fault-finder, and such a statement from it deserves unusual weight on that account. It should also be added that the New York Telephone Co. has expressed its willingness to have its books examined regularly by the city's representatives and to keep its rates at such a point that not more than ten per cent. shall be earned annually.

In the face of all these facts, there are some people who have been so hypnotized as to believe that another company, seeking permission to install a rival telephone system in the city, can really give a good service at a very much lower cost. It is manifestly impossible for any length of time. On the strength of such assertions, rival telephone systems were introduced at St. Louis, where the introductory rates have since been raised 20 to 33 per cent.; at Cleveland, where the rise has been 33 to 50 per cent.; at Pittsburg, where the increase has been 50 to 61 per cent.; at Toledo, where the increase has been 18 to 23 per cent.; at La Crosse, where the rise has been 20 to 33 per cent.; at Madison, where the rise has been 16 to 37 per cent.; at Galesburg, where the increase has been 20 to 33 per cent., and at other cities which it is unnecessary to mention. In all these places, the people have at last waked up to the fact that the rival service has not only been a failure, so far as being a cheap service, but has really been a source of unnecessary expense.

This latter assertion is readily seen to be true when the nature of telephonic communication is considered. The best service is that which connects the most people, not only in the city, but also through long-distance wires. Anything that reduces the number of instruments impairs the service that can be rendered. The business is one that specially deserves protection by an exclusive franchise. Even such a hide-bound trust smasher as Prof. R. T. Ely wrote: "Two telephone companies cannot perform the same service which one can perform, inasmuch as complete unity is lacking. The object of the telephone is to bring people together, and the more completely it does this, the better it performs its functions. Two or more competing telephone plants, however, separate people and thus operate antagonistically to the purpose for which the telephone was established." In granting a monopoly it is, of course, desirable of retaining a certain measure of control over the service so as to safeguard the public interests, but the control offered by the New York Telephone Company is all that any sane person would consider desirable.

It is unfortunate that the extra expense of a duplicate telephone service falls most severely on those people least able to bear it. Retail tradesmen find the use of both systems compulsory, for if they have but one they are certain to lose the trade of families having only the other. The installation of a small number of competing telephones in residence districts is sufficient to force a much larger number of grocers, butchers, bakers and other small tradesmen to install both systems. The number of subscribers to independent telephone companies alone is rarely above a third of the total number of telephone subscribers in a city, yet this number adds an enormous unnecessary expense to telephone service. For instance, in Philadelphia but 6 per cent. of the telephone subscribers use the independent system exclusively, but because of this small number, 16 per cent. of the subscribers have been forced to install duplicate services and pay a total of $500,000 to $800,000 annually, most of this sum being a compulsory waste of money. In Atlanta, 10 per cent. of independent exclusives compel 18 per cent. to pay dual charges; in Saginaw 20 per cent. compel 38 per cent. to install both systems, and in Columbus, Ga., this wasteful outlay is imposed on 21 per cent. to secure the convenience of 8 per cent.

Such a situation is so uneconomical that it should be prevented. Competition in such business is only desirable as a rule where public regulation of charges is impracticable. This regulation is possible in New York and there is accordingly no reason for granting a franchise for a competing telephone company. The Engineering Record knows by experience in some of its branch offices that the dual service is a nuisance and not a benefit, and it hopes that none of its readers will believe for a moment the absurd offers to furnish telephone service at less than cost.

The Report on Engineering Education by a Committee of the Institution of Civil Engineers.

This report on the educational training of engineers is a contribution of marked value to that general subject, although it is naturally applicable to the conditions of the profession in Great Britain rather than to some of those existing in this country. The Institution of Civil Engineers has shown a most commendable interest in the educational training of engineers for many years. As long ago as 1868 it made "an exhaustive inquiry . . . into the then existing conditions and systems of engineering education in the United Kingdom and in foreign countries." Inasmuch as the system of engineering training in Great Britain has differed rather radically in some respects from the training of young engineers in this country, it may be remarked at the outset that some of the recommendations of the committee making this report will not square entirely with the views in reference to similar training entertained by some engineers and instructors in this country. At the same time the report is worthy of careful study by every one interested in engineering education in the United States. It expresses not only the views of British engineers, but those of many experienced instructors in engineering like Sir A. B. W. Kennedy, Prof. Archibald Barr and others of nearly equal prominence. The investigations of the committee have covered a period of nearly two years and a half and they have been conducted in large measure by securing the written opinions of 267 instructors and practitioners. The views expressed, therefore, are based upon a widely extended engineering judgment.

The work of the committee was divided into four parts relating, first, to preparatory education in secondary schools; second, to what may be termed practical training in offices and works; third, training in universities and higher technical institutions, and fourth, post-graduate work. In this division there will be observed the prominence of the old English idea that in the educational training of an engineer there should be found a thoroughly practical element, indicating that no engineer could consider his educational training complete without having been engaged in actual work-shop operations. It is probably in this respect that a considerable number of American engineers and engineering instructors may fail to agree wholly in the expressions of the English members of the profession. At the same time it is only fair to observe that in one or two of the most advanced courses in engineering study in this country, one of these being found in a prominent university, the element of work-shop practice is insisted upon as a highly valuable element. And it is further to be observed that this practical training in the workshop is after all but parallel to the admirable field surveying instruction which is also made a marked feature in all the best engineering courses of study in the United States. Surveying and shop-work practice really constitute the rounding out of the practical field of the engineering profession. It is apparently the view of the English engineering educator that the actual doing of things in the workshop as well as in the field is a necessary part of an engineer's educational training and it would be very difficult to controvert successfully that statement.

The recommendations of the committee with respect to preparatory education are practically identical with the views accepted in this country in regard to the same subject. It is stated that the student "should not commence his special training until he is about seventeen years of age." This conforms well with American practice. As a matter of fact students entering the engineering schools of the United States are usually found in age between seventeen and nineteen years. The qualifications regarding subjects will also be found to harmonize closely with American practice. There are one or two details, such as a recommendation regarding the usefulness of an elementary knowledge of Latin, that many American engineers would probably disapprove. As, however, it is rapidly coming to be recognized that the general education of engineers should be broader and more thorough than was formerly supposed necessary it is not unlikely that even the Latin element may hold its own.

That portion of the report relating to professional engineering training, including practical training in offices or works and that given in universities and higher technical institutions, as well as post-graduate work, presents a subject about which a great variety of judgments may rationally be expressed. The committee appears to favor one year of practical workshop training before entering the professional school, although two years are suggested should the boy complete his preparatory education at the age of sixteen. Three years of educational training in the technical school would then follow, although a fourth might in exceptional cases, be added. The remaining two or three years of workshop or office practice would finally complete the education schedule proposed by the committee.

This programme would make a full-fledged young engineer after not less than six and not more than eight years of educational work, about one-half of which would be spent in the professional school, and one-half in gaining practical experience. It is thus clear that the apprentice idea still holds an important place in the British engineering educational programme. It is furthermore interesting to observe that the committee insists that "a sound and extensive knowledge of mathematics is necessary in all branches of engineering," and that "to this fundamental mathematical training there must be added instruction in applied mathematics and mechanics." These expressions regarding instruction in mathematics and mechanics, however, are coupled with the most unqualified injunctions that those subjects of pure theory should be so treated as constantly to show their practical bearings on actual engineering problems.

As has already been observed these salient features of the committee's report in the main are in essential harmony with the educational practice of the principal engineering schools of this country, but there are certain differences of a rather fundamental character. The general trend of development in American engineering education is toward placing it in the same category with the professional schools of law and medicine. In other words the most advanced engineering schools of the United States are steadily moving toward about a six years' course of study divided approximately equally between the academic course of college study and those subjects which are entirely technical in their engineering character. Although limited shop practic would be given in the early stages of the technical work no practical shop training would be required. From the American point of view the training required by the committee's report would be materially deficient in purely educational work. Furthermore, it appears to be the judgment of the American engineer and engineering educator that practical shop training, so strongly insisted upon by the English committee is, and can best be regarded as a part of the first few years' practice of the young engineer. Three years, or in the exceptional case, four, certainly seems to be too limited for the professional education required by the finished engineer of the present time. There are few or no American courses of engineering study, of standing, less than four years in length, and the urgenut need of the preliminary general training of the college course is most marked. Nor is there any valid reason apparent why the true educational training of the engineer should be broken in its continuity and reduced in its efficiency by being abandoned one or two years for practical work. The practical training of the young engineer is logically and necessarily an integral part of the work of the first few years of his practical experience. On the whole it is not clear that the committee of the Institution has not indulged in a little too much conservatism for the best interests of engineering as a profession.

The Write-Up.

Some of the readers of this paper have doubtless been interested in a couple of articles on the subject of trade journalism, recently published by an elderly Philadelphia contemporary. It is really not the part of business courtesy for a fellow-publisher, even if he has inherited the wig of Benjamin Franklin, to give away to the general public so much inside information concerning the delightfully soft snap enjoyed by those engaged in this business. It is all right, of course, to indicate that trade journalism is able to keep the wolf away from the door and even to furnish a dollar table d'hote on an occasional Saturday night when subscribers have paid up in real money instead of compliments on the character of the paper; but it is a cruel blow from a brother's hand to show what a very easy thing it is to run such a journal. The author of the articles points out that people without the strength or inclination to take part in the arduous duties of daily newspaper work will find in trade journalism the combination of easy berths and fat financial returns that brings joy to the bovine spirit, and he further adds that the business end of this particular field has been developed so much more cleverly than the editorial end that a great opportunity awaits the ambitious but indolent pen pusher who thinks the office of a daily paper is too energetic and not literary enough in its atmosphere for his sensitive nerves.

It is possible that these revelations of the conditions in trade journalism will bring an influx of blue blood and bright brains into the midst of this hitherto neglected and unappreciated branch of journalism, and it may be promised that if anybody will show how to describe a new line of planers or an improved method of sewage disposal so as to make it even approach in general interest an account of a good horse race, there is a big place waiting for him in many offices. But even the most enthusiastic press agent cannot conscientiously say that it is easy to prepare a technical write-up of which he can feel proud from a literary point of view. He demands the insertion of his gems of thought on the ground that they refer to things he is advertising, but he also seems to think the editor will be glad to be relieved of the duty of filling the space that is occupied by the write-up of a new lathe, say, telling all about it from the size of its feet to the color of its paint and illustrated by a cut taking up most of a page. Judging from the revelations in the "Saturday Evening Post," it might be well to head off a legislative inquiry into trade paper short-comings by acknowledging that such a publication gains prestige in its special field, not because of any merit in its reading pages, but because of the earnest desire of its subscribers to help along the needy publisher. This critic seems to feel that if there is not enough room in the narrow confines of paid advertising space for the description of a manufacturer's wares the fulness of the reading pages is at his disposal; in fact, that is what they are provided for, and the technical information of an unbiased character which they contain is depended upon only to fill the places not occupied by this trade information for which the subscribers yearn so strongly.

As a matter of fact, a considerable part of the articles referred to is misleading nonsense, and lest some of the readers of them who also look to The Engineering Record for information may be misled, it is worth while considering this one feature of trade journalism, the write-up. The author of the two articles states that the reading pages of trade papers are not conducted as well as the rest of the business; and overlooks the fundamental fact that the men who produce those reading pages are employed by the owners of the papers to work along certain lines. If their work was not satisfactory they would be discharged; the fact that they are not discharged shows that they are considered competent. These editors are not responsible for the write-ups that appear in the reading pages, but the publishers are. If it is the policy of a journal to sell its reading pages to advertisers, the editors are in no way guilty. It should be thoroughly understood, however, that the best trade papers do nothing of this sort. All the space they sell or promise to advertisers is in their advertising pages. It is worth all they charge for it, generally more than they charge. The high-grade paper has a large number of subscribers just because of their certainty that whatever appears as reading matter is printed solely on account of its real interest to the readers. These subscribers, the cream of the class to which the publication appeals, are worth reaching by advertising. By maintaining the reading pages free from paid notices, this group of readers is kept so interested in the regular issues of a publication that its advertising pages always form the quickest and best means of telling a business story to the men whom it is desired to interest. But just as soon as the reading pages are lowered by write-ups, the subscription list dwindles in numbers and importance, and for the sake of some trivial gain for a month or a year, the great value of having all the best men in a given trade or profession reachable through a single journal's pages is lost for all time.

There is one feature of the write-up that is not rightly appreciated. A few days ago a company sent an advertisement to this journal with the following note: "Other magazines have promised to give us a reading notice if we place an advertisement with them, and we hope you will consent to do the same." The Engineering

Record will be glad to notice that material; it has been trying to get the information for the benefit of its subscribers for some time, and it would print it without regard to any advertising. The limitations of the human memory are not widely separated and that article will be forgotten before long, except in a very hazy way. Accordingly the advertisement is necessary to keep the reader reminded of this useful product as well as to attract the attention of the new readers. This is the only true theory of write-ups and advertising. Any trade paper that influences educated classes like those reached by The Engineering Record adopts this theory, and any paper claiming to reach such people and at the same time offering to give write-ups in return for advertising is not worth spending any advertising appropriation in.

It must not be thought, however, that any old thing is acceptable for the reading pages of a high-grade journal. It happens sometimes that an advertiser prepares his advertisements in such a poor way that they attract no attention and tries to recoup his losses by contributing similar reading matter for the editor's use. He cannot make his articles of much value in the space for which he pays, and accordingly desires to bring the reading pages, for which he does not pay, down to his own level. No good paper ever countenances such a practice. The editor is the man who represents the subscribers in the organization of a trade publishing house, just as the business manager generally represents the advertisers. The two departments are entirely distinct on all good publications, much more distinct than they are in newspapers, and contributions from an advertiser are judged by the same rules that are applied to everything else. If the contribution is of interest to the subscribers it makes no difference where it comes from; if it is not considered of interest it is not printed. Many manufacturers and dealers appreciate the rules of different editorial offices and fix up their contributions in conformity with them, thereby gaining considerable publicity at little expense. Other companies turn out the most crude type of boyish effusions, without any interest to anybody, and claim that discrimination is shown against them when these contributions are rejected.

The Public Obligations of the Engineer.

In an address at the University of Tennessee a few days ago, Mr. Alexander C. Humphreys called attention with characteristic forcefulness to the public obligations of the engineer under such a system of government as our own. He pointed out the grave menace to industry and commerce which the yellow newspaper and yellow magazine present through their constant attacks on the honesty of business men and the integrity of public officials. Such an attempt to arouse people of small incomes against those of larger means overlooks the fact that the moment a man takes out an insurance policy or opens a savings bank account he becomes a capitalist, and any clamor that makes him unnecessarily lose confidence in his investment is a serious menace to public welfare. The newspaper clamor against insurance companies resulted in the case of the Equitable Assurance Association in the lapsing of 27,385 policies for $1,000 or under. Of all the policies that lapsed 84 per cent. were for $3,000 or less, practically all of them being unquestionably held by earners of moderate wages. Yet there has never been a moment when these policies were in any way threatened, and the newspaper revelations, so-called, would indicate to any policy holder not bewildered by the yellow journalist that his life insurance investment would become more secure as a result of the improvements certain to result from the attention drawn to undesirable features of management. In this one company alone, thousands of policies lapsed, causing the needless loss of considerable sums previously paid in premiums, solely because the yellow publications preferred sensation to sense. In such situations, the engineer is often so situated as to enable him to render excellent service in keeping the wage earners from becoming deceived. His position in industrial establishments and on undertakings employing many men, gives him their trust, for the know his training has been such as to develop logical habits of thought. The men are more closely in touch with him than with the executive officers, and he is therefore in a position to counteract the pernicious influence of the irresponsible sensational newspaper and magazine.

There is another way, in some respects more important than that just mentioned, in which the engineer should assume a leading part in public affairs. "Is it not true," Mr. Humphreys asked, "that the engineers and industrial managers have been generally regarded as narrow specialists, set apart to do their particular task in the world, and have they themselves not been all too ready to accept this view and so absolve themselves of responsibility in connection with questions of public policy?" This question is a very serious one. Legislative bodies are passing laws relating to technical subjects and public commissioners are passing regulations governing the way in which manufacturing processes shall be conducted and business enterprises carried on. These laws and regulations, to be of service to the public, must be drawn and enforced by men with technical ability and business knowledge. This fact is not at all appreciated by the public, and so we have one commission setting aside the laws of nature by public proclamation, another ignorant of the importance of depreciation in mechanical plants, and a third prescribing ridiculous conditions for the water and sewerage works over which it has been given supervision. The engineer laughs at these displays of ignorance, unless he is personally affected by them. Instead of laughing, however, he should be vigorously protesting against them. Let any such thing happen in the field of medicine or of law, and the public knows of it instantly. The professional bodies take action, directly or indirectly, and the better grade of newspapers receive letters from professional men of standing calling attention to the mistake. The timid engineer, however, rarely utters a single twitter in public when his own specialty is made the sport of enthusiastic ignorance. If he writes a protest to the newspapers he is afraid to sign his name to the letter, or he scares the editor by attempting to back his assertions with an uninteresting technical treatise on the subject, so heavy that it cracks the waste-basket into which it is always thrown.

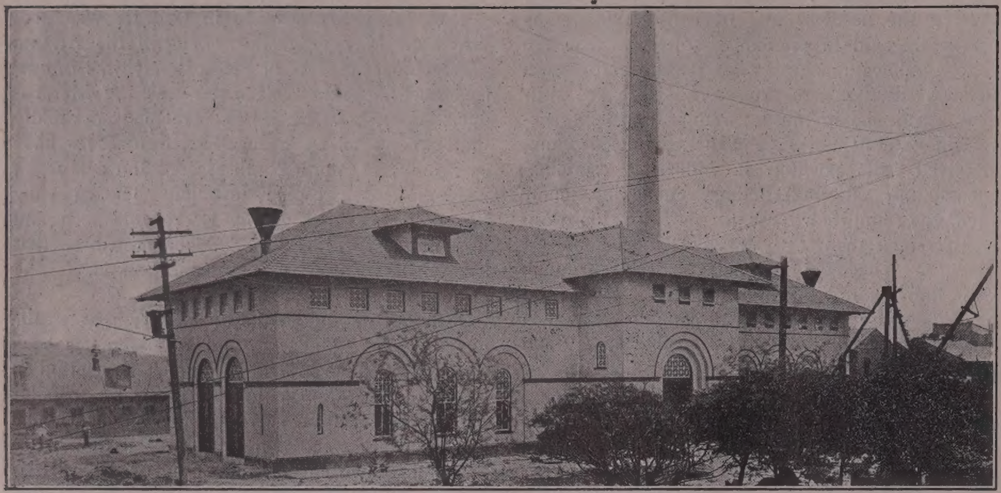
It is every man's duty to play an active part in public affairs. The reason that bad administration occasionally takes place is because the men who can prevent it shirk their public obligations. So much depends on good technical administration to-day that the engineer must wake up and play his part in molding public opinion. "To be efficient," Mr. Humphreys well said, "the engineer must not only be able to make practical applications of science, but he must be competent to recognize and conform to commercial limitations and conditions." The Engineering Record would add to this the further statement that to be efficient in the broadest and best sense the engineer must insist that laws and regulations concerning engineering matters should be technically reasonable. There will always be differences of opinion on engineering details, but it is the engineer's duty to protest vigorously against the violation of the indisputable basic principles of his specialty by public officials.

Notes and Comments.

THE FIRST STEEL made in Georgia was produced on May 10 at the works of the Atlanta Steel Hoop Co. When the company was organized steel hoops and cotton ties were the sole products, but the business has developed so rapidly that two 35-ton basic open-hearth furnaces have been built, a blooming mill erected and a Morgan rod mill and nail plant installed. The company has been financied wholly by Atlanta men and uses only Georgia ore and Alabama pig, so that it is distinctively a Southern corporation.

THE TUNNEL under the East River between the lower end of Manhattan and Brooklyn has been the subject of so much sensational description in the daily papers lately that it is desirable to point out a few facts concerning the subject. The statements that the two tubes of the tunnel are flattening down so that the safety of the work is threatened are misleading, and the announcement that the condition has just been discovered is entirely incorrect. As a matter of fact the engineers connected with the work, both for the Rapid Transit Railroad Commission and the contractors, have known of the conditions for a long time and have never made the slightest secret about them. The Engineering Record has been informed concerning these conditions for many months. The reason that nothing has been said about them has been because they were not of enough interest to make it worth while. It is perfectly true that there has been a flattening of the tubes in places and that deviations from the grade have occurred, but these can be remedied without any great trouble and it is difficult to see why the repairs should seriously delay the opening of this portion of the rapid transit railway system. If the authorities allow themselves to become scared into following the advice of newspaper engineers the opening of the tunnel will be delayed indefinitely, but if they will help instead of hinder the repair work the result will probably be satisfactory to the public and everybody will soon see that a mountain has been made of a mole-hill.

THE SEA-LEVEL CANAL seems to have been recommended for Panama by the Senate Committee on Interoceanic Canals largely on account of the recent earthquake in California, for in its report advising the adoption the following statements occur: "The recent calamity that overwhelmed one of our great cities has caused many forebodings. The assertion that any particular spot in the tropics is exempt from all danger from such convulsions of nature as recently visited California, or wrought great havoc near Charleston, S. C., in 1886, or changed the face of nature in southeastern Missouri, near the beginning of this century, would not be hazarded by any wise man. That the Isthmus of Panama is not exempt conclusively appears, and we can have no guaranty that the canal zone will in the future be exempt from such disasters. The canal structures that would be most exposed to injury by the passing of an earthquake or violent movement of the earth surface are the locks proposed by the minority, whose walls, many hundreds of feet, or even two or three thousand feet long at Gatun, would, at least some of them, be more than 75 ft. high and entirely unsupported on one side save for a part of the height by water. If these walls should be moved at all, the natural and probable result would be in their leaning, and so prevent the closing of the gates—an injury for which a suggestion of extra gates on hand would be useless, for no one could guess the extent of the movement. But the most likely effect of such shock would be the fracture of these locks, in repairing of which much time—months or years—might be required, and thus cause interruption of traffic or the abandonment of the canal."



Front View of Pumping Station A, New Orleans Sewerage System.

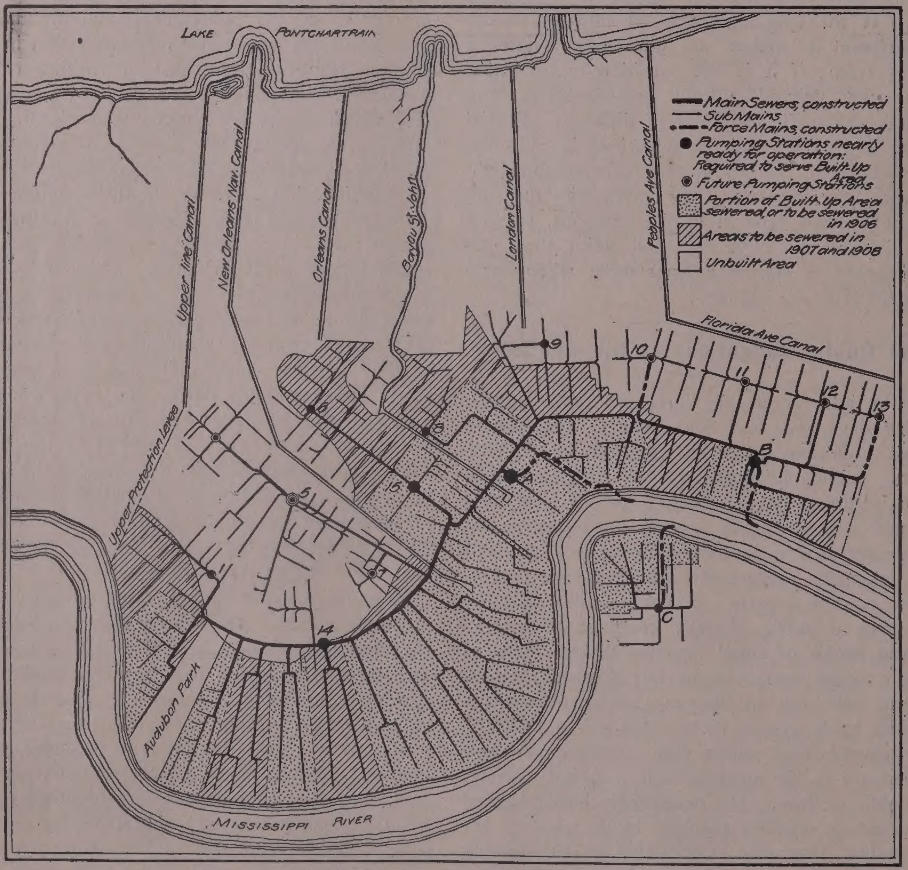
THE SEWERAGE SYSTEM OF NEW ORLEANS—I.

The most important parts of the sewerage system for New Orleans, La., will be finished and put into service within a few months. The city has a population of approximately 325,000, and is on a long bend in the Mississippi River, 100 miles from the mouth of that stream. A large portion of the city is on a semi-circular neck of land surrounded on three sides by the river, the bend in the latter approaching closely the shape of a crescent. The land on which the city is built is entirely alluvial to a great depth. It slopes away from the bank of the river, where the average elevation is about 13 ft. above mean water level in the Gulf of Mexico, toward two low ridges of land, 6,000 to 10,000 ft. back from the river. Along the river bank for a width of a few hundred feet this slope is considerable in most places. Between the limits of this slope and the inland ridges is a broad area that is on or just below mean water level in the Gulf. The high-water stage in the Mississippi River at New Orleans is 18 ft. above this level, but the city is fully protected from overflows from the river by a levee along the bank of the latter, the crest of which is usually 4 ft. above the high-water stage. Protection levees above and below the city extend from the river front levee along the river to the low ridges inland. Back of these ridges, which have been formed by overflows from tributaries to the river, is a tidal swamp, 1 to 3 miles wide, bordering on Lake Pontchartrain, a very large inland body of slightly brackish water connected with the Gulf of Mexico.

Owing to the topography of the site of the city, the storm-water run-off and the domestic-sewage flow both have to be pumped. An old system of drainage canals and pumping stations was installed about 33 years ago, but this system was entirely inedaquate to handle the storm-water flow. The construction of a complete new system of drainage canals and pumping stations, which will collect and discharge the storm-water run-off was started in 1897. The portion of the project undertaken at that time was completed and put in operation in 1900. The general plan of this drainage system was described in detail in The Engineering Record for Nov. 11, 1899. This plan contemplates the construction of a main covered drainage canal from the center of the city to a pumping station near the protection levee extending inland from the river along the lower side of the city. From this pumping station a main outfall canal extends through a natural bayou to Lake Borgne, a salt-water lake similar to Lake Pontchartrain and 14 miles down the river from the city. Covered sub-main channels are to be built throughout the city from the main covered channel, the storm water being delivered to the sub-channels by gutters along the streets and by lateral collecting systems. Four of the sub-main channels are to be equipped with pumping stations which will discharge into emergency relief outfall channels leading to Lake Pontchartrain.

Three of the four sub-main channels, which have pumping stations and relief outfalls, and the greater portion of the smaller sub-main channels and lateral collecting systems in the congested portions of the city have been in operation for several years. Owing to the desirability of constructing a sewerage system to dispose of the household and other wastes and a water supply and distribution system, the main drainage channel has not been completed and the outfall canal leading to Lake Borgne has not been constructed. The drainage flow is at present diverted to the pumping stations on the three sub-main channels, and discharged from those stations into the channel leading to Lake Pontchartrain, pending the completion of the drainage system. The pumps which are intended to ultimately handle the excess flow from heavy storms only, are at present installed and discharge all of the flow reaching the drainage channels.

The rates of rainfall in New Orleans are exceptionally heavy, as may be seen from the accompanying diagram made up from accurate data of various rates of rainfall in New Orleans from 1895 to March, 1906. In making this diagram all rainfalls which exceeded 1 in. were first arranged; then these storms were plotted with their most intense rates of rainfall shown first and decreasing rates following. Detail beyond five hours was not sought, because in no case did the intense portion of the storm exceed such duration. Equal divisions of 0.1 in. were taken on the 5-minute line and the number of storms falling within each division were counted. An equal number of storms at each succeeding division of time, that is, 30 minutes and 1, 2, 3, 4 and 5 hours, were counted and the lines drawn through points thus determined. The diagram is believed to be quite accurate for 5 hours. Beyond that period the lines are continued so as to divide the storms according to their total precipitation, and assuming a total duration of 8 hours, which was the average duration of all storms. Storms of less than 5 hours duration were carried out by horizontal lines on the same principle on which the count was made.



Map of the Sewerage System of New Orleans.

The dotted lines represent conditions which occurred only once in 10 years. The dotted and dashed lines are approximately the capacity of the various present pumping installations to remove the rainfall from 15,000 acres tributary to the system. The slope of these lines indicates the total pumping capacity, assuming all rainfall to reach the pumps exactly as it falls. Their position is arbitrarily placed so as to allow for the reservoir capacity of the drainage channels and other factors governing the run-off; and also to be below rainfalls which would exceed the capacity of the pumping stations. The legend on the diagram explains the plotting of various other data. The New York storm referred to is that which caused great damage in the vicinity of New York City early in October, 1903, and is plotted to show the relation between its intensity and the rates of rainfall in New Orleans. This diagram is, of course, merely illustrative and is not expected to give more than a general idea of the relation of the very complicated data summarized in it. In fact it merely brings together for comparison with rainfall rates the removal capacity of the various pumping installations. These capacities are shown by the slope of the lines and may be moved parallel with themselves to any point of origin as required by the conditions surrounding any particular storm.

The effect of the operation of the drainage system since it was put in service in 1900 has been very marked. The average total death rate for New Orleans from 1890 to 1900 was 28 per 1,000. The average death rate in New Orleans from 1900 to the end of 1905 was 21.5 per 1,000. While the drainage system has probably not been alone accountable for this entire decrease, it has undoubtedly been a considerable factor. The ground water level in much of the area served by the drainage system has been lowered until a number of sections that were formerly swamps have been reclaimed and are now being built up. The completion of the drainage system may be delayed by lack of funds until 1908, at which time the parts of sewerage and water works systems required for present needs are expected to be finished and funds will then be available for the construction of the remainder of the drainage system. Permission to make an additional bond issue of $8,000,000 is being requested of the state legislature, however, and if this permission is granted, between $5,000,000 and $6,000,000 will be immediately available to carry forward the work on the drainage system.

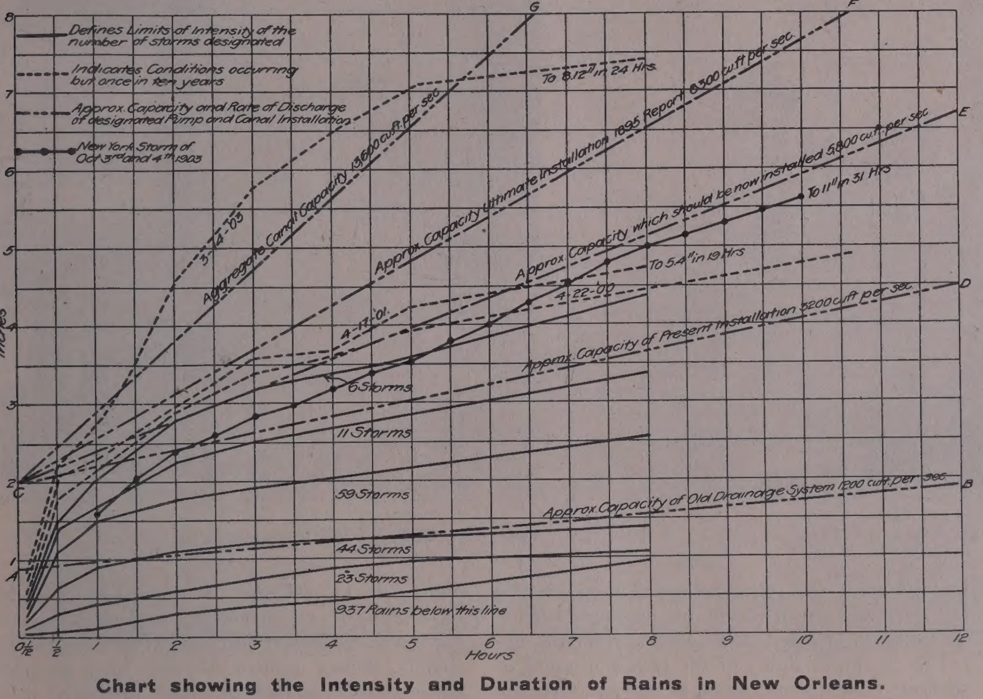
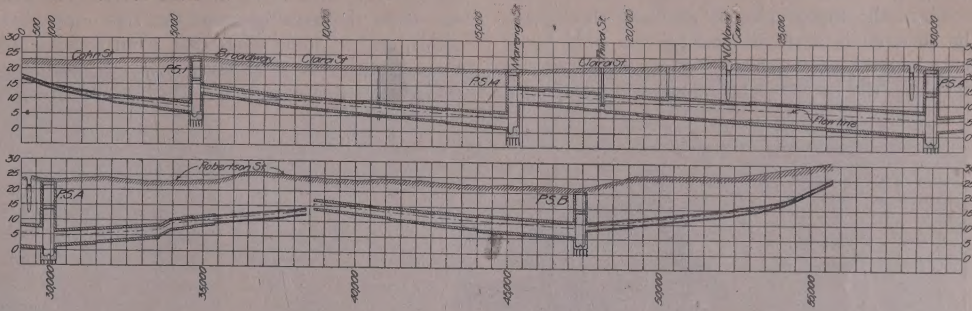


Chart showing the Intensity and Duration of Rains in New Orleans.

A few of the larger business houses, hotels and public buildings own or are connected with private force mains, through which their sewage is forced or pumped by the nearest route into the Mississippi River. Some of the better class of residences are fitted with modern plumbing connected with cesspools, which in many cases leach into the surrounding ground, or occasionally overflow, illegally, into the gutters along the streets. The great bulk of the estimated 65,000 premises in the city are served, however, by the crudest of closets in the rear, the contents of these closets being removed at intervals. Waste water from bathrooms, laundries and kitchen sinks is usually turned directly into the gutters along the street. As the ground-water plane is normally within 2.5 to 3.5 ft. of the surface under much of the city, the gutters in parts of the city contain, during at least a part of the year, liquid refuse in which septic action is very evident.

With the exception of the few private sewers mentioned, the city is at present without the service of a sewerage system. The sewerage system which is being built, a large portion of which will soon be placed in service, has been designed under the very unusual conditions that the construction required for present needs is in conformity with a well-defined and perfected plan which can be filled out and completed as the city develops. The money available for the construction of the system is definitely limited. This limitation is so low that it will not permit the immediate construction of all parts of the system at present desirable, so the portions under construction have been designed to satisfy the present requirements, remain within the limits of the present possible expenditure and still form economical and satisfactory parts of an ultimate complete system. The plans for the system embrace all the territory from the protection levee along the upper side of the city to the one along the lower side, and from the river back to the low ridges along the rear of the city, an area of 22 square miles. They also embrace an area of a square mile on the opposite bank of the river, where a practically separate town annexed to the city is located. These plans include 900 miles of sewers, and contracts have been or will be awarded for 275 miles by the end of this year. Covered by these contracts, 200 miles of sewers and the necessary pumping stations, including most of the main and sub-main sewers, have been under construction since 1903 and will be placed in operation shortly.

A franchise to build a sewerage system covering much of the most developed portion of the city was granted to a private company by the city in 1892. Mr. George G. Earl was the chief engineer of the company, and Messrs. Rudolph Hering and B. M. Harrod were the consulting engineers. This company proposed to build a main sewer along the rear of the area to be sewered and pump the flow reaching this main sewer through a force main leading to the river. The company failed after 3,600 ft. of the main sewer and several miles of pipe sewers had been constructed. Practically all of these mains were purchased by the city, and, as the same general plan proposed by that company is followed in the present work, these mains have been included in the latter.



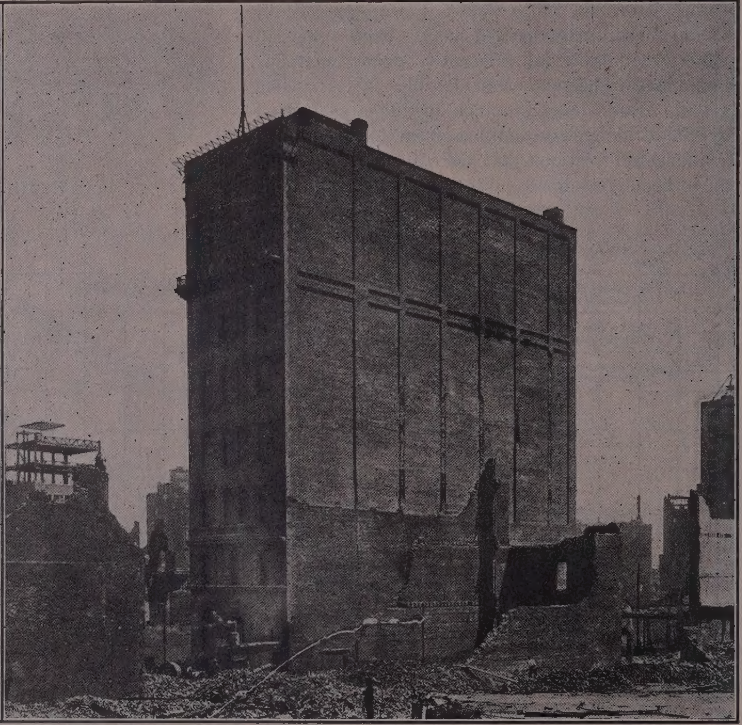
Profile of Main and Submain Sewers Parallel with River.

In estimating the amount of sewage for which provision had to be made, the house drainage and the ground water reaching the sewers were both taken into account. As the existing water-works system is limited to a very small portion of the city, no water consumption data were available. In areas under 200 acres the maximum house drainage was estimated to be 160 gal. per capita in 24 hours. The ground water flow estimated to reach the sewers is placed at 0.003 cu. ft. per second per acre, or 1,250,000 gal. per square mile in 24 hours, which is 25 per cent. more than one-third of the average annual rainfall. The ground-water flow into the old sewers built by the private company was measured and found to be quite close to the quantity assumed. For all areas over 2,000 acres, the sewers are proportioned for a daily discharge equivalent to 100 gal. per capita per 24 hours, including ground water. The rate of run-off in areas between 200 and 2,000 acres is considered to be inversely proportional to the area drained.

Owing to the unusually flat grades throughout the city, the sewage cannot be delivered to the main collecting sewers along the rear of the city by straight lines of laterals running from the river to that main, or from the initial point to the main. Straight laterals would soon attain such depth, without collecting enough sewage to increase their size and thus lessen the slope required, as to make them very expensive to construct. Furthermore, straight laterals would require the main collecting sewer to be located much nearer the river front than it has been built, leaving large areas of flat territory in the rear where collection to local wells and pumping from these wells would have been required. The sewerage system has, therefore, also been designed so that the flow in the laterals is rapidly concentrated into large sewers or sub-mains.

The natural slope of the ground directly along the river is away from the latter and is greater in most places than the minimum slope required for the sewers so that the method of rapid concentration of flow in this area is greatly facilitated. The general plan has been to select two points, one on a main or sub-main and the other in the area to be sewered, the two points being as widely separated as possible without exceeding the specified depth, or making too long a distance for effective automatic flushing. The sewers are then run between these points alternately at right angles to and parallel with the river, until a junction is effected with the sub-main or main. The laterals are also designed so that water from flush-tanks at the head of each lateral will traverse the entire length of the latter without an excessive number of tanks. By this method the sewage is carried 9,000 ft. in a lateral to a main in some places, with a maximum cut of from 10 to 13 ft.

Marsdon Building, under Construction at Time of Fire.



Pacific States Telephone & Telegraph Building.

Since the topography of much of the area to be sewered is such that grades can only be secured in the sewers by constantly increasing the depth of the latter, or by frequent re-pumping of the sewage, each foot of fall in the sewer generally requires a corresponding increase in its depth below the surface. An attempt, therefore, was made to obtain the least inclination compatible with efficiency and economy of operation. Although this lack of natural slope was an expensive disadvantage, the fact that the entire sewerage system could be designed as a whole and that the grades and velocities were determined and established by calculation rather than by topography, permitted ideal conditions of grade and velocity to be secured. The entire system, starting at the dead ends of the laterals and continuing to and through the largest mains, is designed to produce a uniformly accelerated velocity of flow in the sewage in it. All sizes of sewers up to and including those 18 in. in diameter are designed to run half full under maximum conditions; above 18 in. in diameter, all sewers will run 0.7 full under maximum conditions. A grade of 1 ft. in 300 ft. was adopted for the 8-in. laterals and will produce a velocity of 2 ft. per second in them when they are filled to the theoretical flow line. As the size of the sewer increases the grade is arranged so that a gradually accelerated velocity, increasing from 2 ft. per second in the laterals to 3.66 ft. per second in the largest main, is secured. The flow will thus increase in carrying power as it advances and any matter capable of transportation in the upper reaches of the system will be steadily pushed along to the point of final disposal without danger of stoppage or obstruction.

The peculiar shape of the built-up area of the city, extending for a great distance parallel with the river, but for the most part extending but a short distance back from the latter, combined with the necessity of discharging the sewage into the river below the central portion of the city required a careful design of the mains transporting the sewage laterally. Gravity mains parallel with the river along the rear of the city were considered the most efficient and economical means of carrying the flow to the pumping stations discharging into the river. The sewage from the area between the river and these mains, and in some cases that from considerable areas in the rear is received and transported by gravity to these mains. The profiles of the gravity mains and collecting sewers parallel with the river are shown in one of the accompanying illustrations. These mains extend from the upper to the lower limits of the city, a distance of 56,000 ft. They were located as far back from the river as the elevation of the entering sub-mains would permit, in order to secure a greater area tributary to them by a gravity discharge and to reduce the length of sewer to be built. At the same time, the depth of excavation due to the lower elevation of the ground was decreased, and as the heavy work was largely in undeveloped and unpaved streets, the damage to traffic and property was reduced to a minimum.

Even with the method of rapid concentration of flow that has been followed, several pumping stations beside those discharging into the river have been required in the system to secure satisfactory operation of the latter without reaching excessive depths with the mains. Since the slope of the natural surface could not be followed and a gravity transportation of the flow secured, as soon as the limiting depth of trench was reached a pumping station had to be installed. Owing to the method of collection and transportation of the sewage and on account of the strip along the river in which considerable natural slope away from the latter exists, the number of these stations has been reduced to a minimum. As the lateral sewers constitute 87 per cent. of the total mileage of the system their maximum depth governs the average excavation of the whole system. The character of the ground in New Orleans is such as to render deep excavation both undesirable and expensive. At the same time, the laterals had to be placed at a sufficient depth to reduce the number of flush-tanks and the cost of operation of the latter to a minimum. A minimum depth of 5 ft. and a maximum depth of 9 ft. for laterals, and a maximum depth of 16 ft. for sub-mains was adopted. These limiting depths, however, were not applied to main sewers, as economy and efficiency of construction and operation were considered to be secured by an increased depth and fewer pumping lifts in the main sewers.

On account of the sloping ground along the river, a strip 5,000 to 10,000 ft. wide, extending from the upper to the lower end of the city, is drained to the collecting sewers without the intervention of any pumping stations. A very slight variation exists in the surface back of this slightly sloping ground, so that local pumping stations are required to serve relatively small areas. The extent of these areas is limited either by such natural boundaries as large drainage and navigation canals, or by the limiting depths adopted. In all, sixteen pumping stations will be included in the sewerage system. Ten of these are first-lift stations serving local collecting areas and are mostly located on sub-mains. Three intermediate stations are required for low lifts in the lines of collecting mains. The remaining three stations are high-lift stations from which the sewage is discharged into the river through force mains. Four of the first-lift stations, two of the low-lift stations along the line of collecting mains and the three high-lift stations have been built and are being equipped for immediate service. The remaining stations will be constructed as the system is developed.

(To be Continued.)

The Effect of the California Earthquake on Reinforced Concrete.

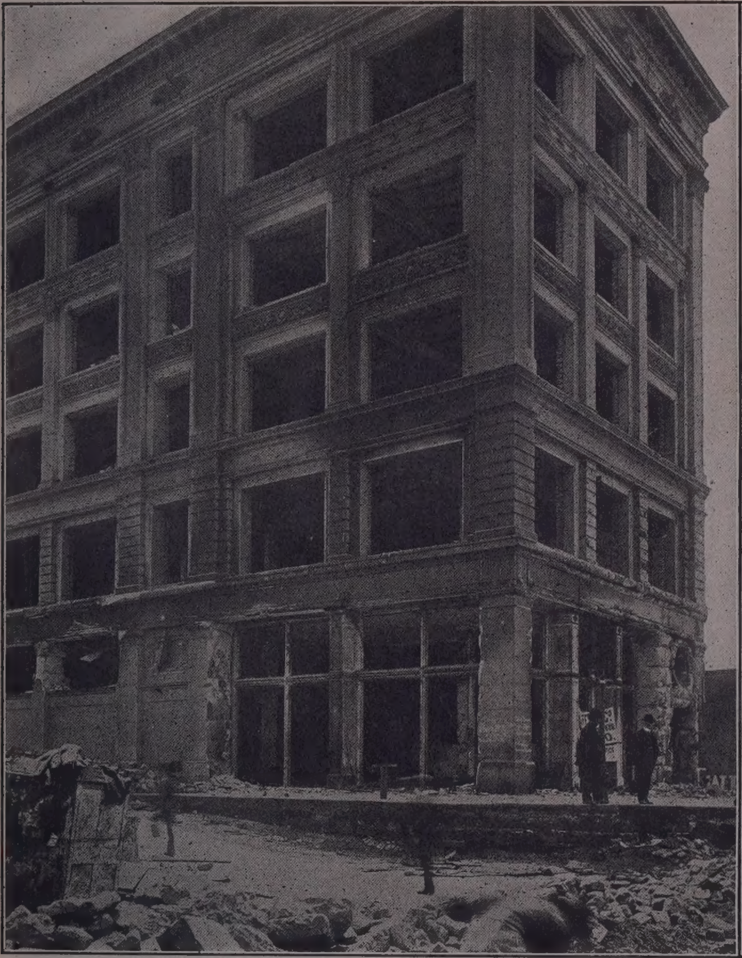
By John B. Leonard, Oakland, Cal.

The great earthquake which occurred in San Francisco on the morning of April 18, followed by three days' conflagration, was probably the most severe test that modern building construction has encountered. A great many conclusions, some of them diametric, will be drawn by those who have been privileged to study the ruins of this city. For the benefit of those who have been unable to make a personal study of the situation and who are particularly interested in reinforced concrete, the writer submits the following views together with such data as he has been able to collect.

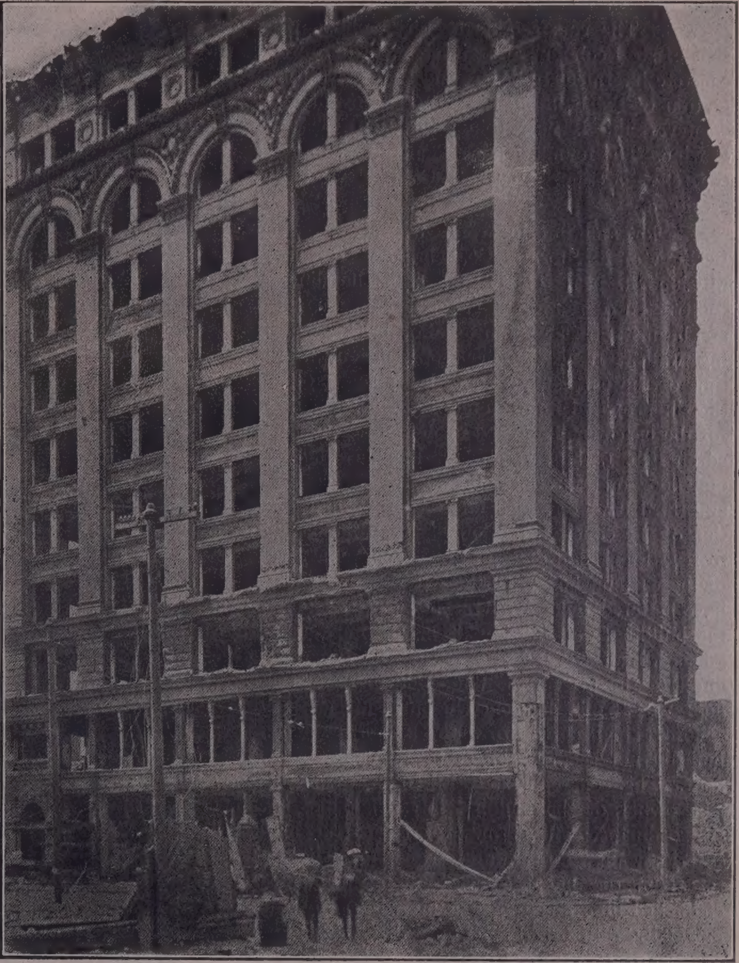
Owing to the antagonistic building ordinance, there did not exist in San Francisco an all reinforced concrete type of building of sufficient magnitude to make our data complete. With but one exception, this construction existed in the burned district only in the form of floor construction and fireproofing. In other sections near the city there were small structures built entirely of reinforced concrete. These received the full force of the earthquake and showed no damage therefrom. They seem to have ridden the waves or vibrations, as one occupant describes it, as though they were so many cast-iron boxes rising and falling en bloc, with an entire absence of the rumbling and grinding noise which was prevalent in all other classes of construction. Two notable instances of this construction were the residences of Wm. B. Gester, of Berkeley, and Henry Gervais, of San Mateo.

An accompanying illustration shows the Marsdon building, situated on Kearney Street, between Sutter and Bush Sts. This building was in the process of construction and in practically the condition shown in the view. It consists of steel columns and steel girders, the floor slabs and intermediate beams being of reinforced concrete. The columns were fireproofed by being incased in concrete. This building did not suffer at all from the fire test, but had a very severe test from the earthquake owing to its unbraced condition. The floors show no cracks and the concrete and the columns appear sound; the exterior brick walls are badly damaged. Messrs. Meyer & O'Brien were the architects.

The Pacific States Telephone & Telegraph Co.'s building was situated on Bush St. near Kearney. The building is constructed of steel columns and beams with reinforced slabs. The condition of the floor slabs is reported to be good. The foundation on the side of the building in the view consists of reinforced concrete cantilever slabs and shows no settlement whatever. Mr. A. Cantin was the architect.



The Young Building.



The Aronson Building.

The Young Building is at the corner of Stewart and Market Sts. This building was within one block of the water-front and everything surrounding it was destroyed by fire, as were also its contents. The floors were constructed of reinforced concrete of the old suspension type in which the strap was exposed on the underside of the beam. Their general appearance indicates that they have gone through terrific heat without appreciable injury. The building is on pile foundation, as it is situated in the portion of the city that is constructed on filled ground. The portion of the street on the corner, it will be seen, has settled on this account about 2 ft. The columns were protected with expanded metal lath and plaster and seem to be in very fair condition. Mr. Herman Barth was the architect.

The Aronson Building was situated at the corner of Third and Mission Sts. This building is constructed of steel columns, girders and beams with reinforced concrete floor slabs. The columns were fireproofed with tile. The floors are all in position and have a good appearance. As can be seen by the view, the fireproofing of the columns is in a lamentable condition. In the basement, there were two columns that were fireproofed with concrete which are intact, while two columns, closely adjoining, fireproofed with tile, have buckled down nearly, if not quite, one foot, from the heat. The present condition of these columns indicates that a large portion of their estimated load must have been relieved by the arching action of the floors above. Messrs. Hemmingway & Miller were the architects.

The Rialto Building was at the corner of New Montgomery and Mission Sts. The construction consists of steel columns and girders with reinforced concrete floors. The two corners marked A and B suffered from an explosion in the interior of the building, the character of which is unknown. The balance of the floor work seems to be in excellent condition. The foundation of this building was also of reinforced concrete. Messrs. Meyer & O'Brien were the architects.

The Kamm Building was situated on the south side of Market St. near Third. This building was L-shaped in plan, the rear portion of the building extending back of the building shown immediately to its left. A severe explosion of some character in the interior of the building did great damage to the rear portion, as can be seen in one of the illustrations. The portion extending back from Market St. to a depth of about 70 ft. is in excellent condition. The construction consisted of steel columns, girders and beams with reinforced concrete slabs. It was subjected to a very severe fire test, but enjoys the distinction of being the first mercantile building on Market St. to be reoccupied since the conflagration. Messrs. Bliss & Faville were the architects.

Two of the accompanying views show the effects of blasting on the Casa Calwa Wine Co.'s building on Townsend St. near Third. The buildings to the east and north of this were burned to the ground. Part of the damage done to the Casa Calwa building was caused by the dynamiting of the adjoining buildings in an endeavor to stop the fire and shows the behavior of the reinforced concerte floors when their span was unexpectedly changed from 20 to 40 ft. by the destruction of part of the wall, the intermediate supporting beam having lost its wall support at the outer end dropped from beneath the slab, even tearing out some of the reinforcing rods attached to the intermediate beam. The floor shows a remarkably small deflection under existing circumstances. The slab on the second floor shows sufficient strength to support not only its 40-ft. length, but the intermediate beam as well, even when the wall support for this beam was destroyed. The construction of this building consists of steel columns and girders with reinforced concrete intermediate beams and slabs. No other portion of the building has suffered any damage whatever and is now being filled with a stock of wine. The foundations were also of reinforced concrete. Messrs. Meyer & O'Brien were the architects.

Exterior and interior views are given of the Bekin Van & Storage Co.'s building on West Mission St. near Thirteenth. This building is constructed of reinforced concrete columns, girders, beams and slabs with exterior brick supporting walls. It was under construction at the time of the earthquake, there being but three of the six proposed floors completed. The concrete for the basement floor and columns was completed on Feb. 1, the second story columns and second floor on March 25, the third floor columns and third floor on April 12. A careful examination of the concrete portion of the building fails to reveal any sign of injury or cracks as a result of the earthquake, while the exterior brick walls have suffered severely. One bay at the front of the building was filled with highly inflammable goods which were destroyed by the fire. The effect of the fire on the underside of the second floor was to pit the concrete only sufficiently to expose a small portion of the rods in a few places but did not seem to affect the strength of the floor. This concrete was less than one month old. The owner of the building intends, if the new city ordinance will permit, to replace the brick exterior walls with reinforced concrete. The conservatism of the previous building ordinances compelled him, much against his wishes, to build originally with brick exterior walls. Mr. Ralph Warner Hart was the architect.

A view is also given of the Ferry Building at the foot of Market St. The construction of this building consists of steel columns, girders and intermediate beams, with reinforced concrete slabs. The entire building rests upon pile foundation; the tower consists of steel columns, beams and bracing, with brick curtain walls faced with stone. The tower having been badly damaged by the earthquake, its immediate reconstruction was imperative; the State Board of Harbor Commissioners have already awarded the contract to the Pacific Construction Co. for its reconstruction in reinforced concrete. All the reinforced concrete floors in this building were found to be in perfect condition and the only necessity for even partially restricting the traffic in the building was caused by the failure in the tower.

There are many other buildings constructed with reinforced concrete floors supported on steel girders, some with steel beams and others with reinforced concrete intermediate beams which are typically represented by the above views.

The Rialto Building.

The reinforced concrete bridge at Pollasky, consisting of ten 75-ft. spans, together with wings, a total length of 780 ft., described in The Engineering Record of Feb. 24, 1906, shows no defect whatever from the earthquake. The 112-ft. concrete arch, designed by the writer, which was built across Dry Creek in Stanislaus County, near the city of Modesto, also passed through the tremblor without showing the slightest sign of crack or failure.

At the present time, so far as the writer is informed, there have been no tests made on any of the ruins, but preparations are now being made to enter into this field of investigation. When this has been completed very definite information will be obtainable as to the damage, if any, suffered by the reinforced concrete construction.

An inquiry among architects and engineers, together with my own observations, has failed to reveal any instance of failure on the part of reinforced concrete. Its general behavior has been such as to make it the most favorably considered material for the rebuilding of San Francisco by the investing public. This uniform expression of confidence by the laymen becomes the more noticeable because of their expressed convictions of the insecurity and danger of brick structures based upon their observation during the destruction of a city. Of the damage occurring by the earthquake in San Francisco, over 90 per cent. of it was visited on the brick construction. The tall steel frame buildings of the "Class A" type have inspired a great deal of confidence through their behavior. However, before a positive statement can be made regarding their condition, a careful examination and survey will have to be made of their connections. The writer is aware of several instances where the rivets have been sheared off entirely and for that reason feeds confident that the condition of these buildings cannot be accurately stated until at least the principal connections have been stripped and thoroughly examined. The adoption of a method for future connections in "Class A" buildings to be built in San Francisco will be greatly influenced, if not wholly controlled, by the conditions found to exist in the present buildings.

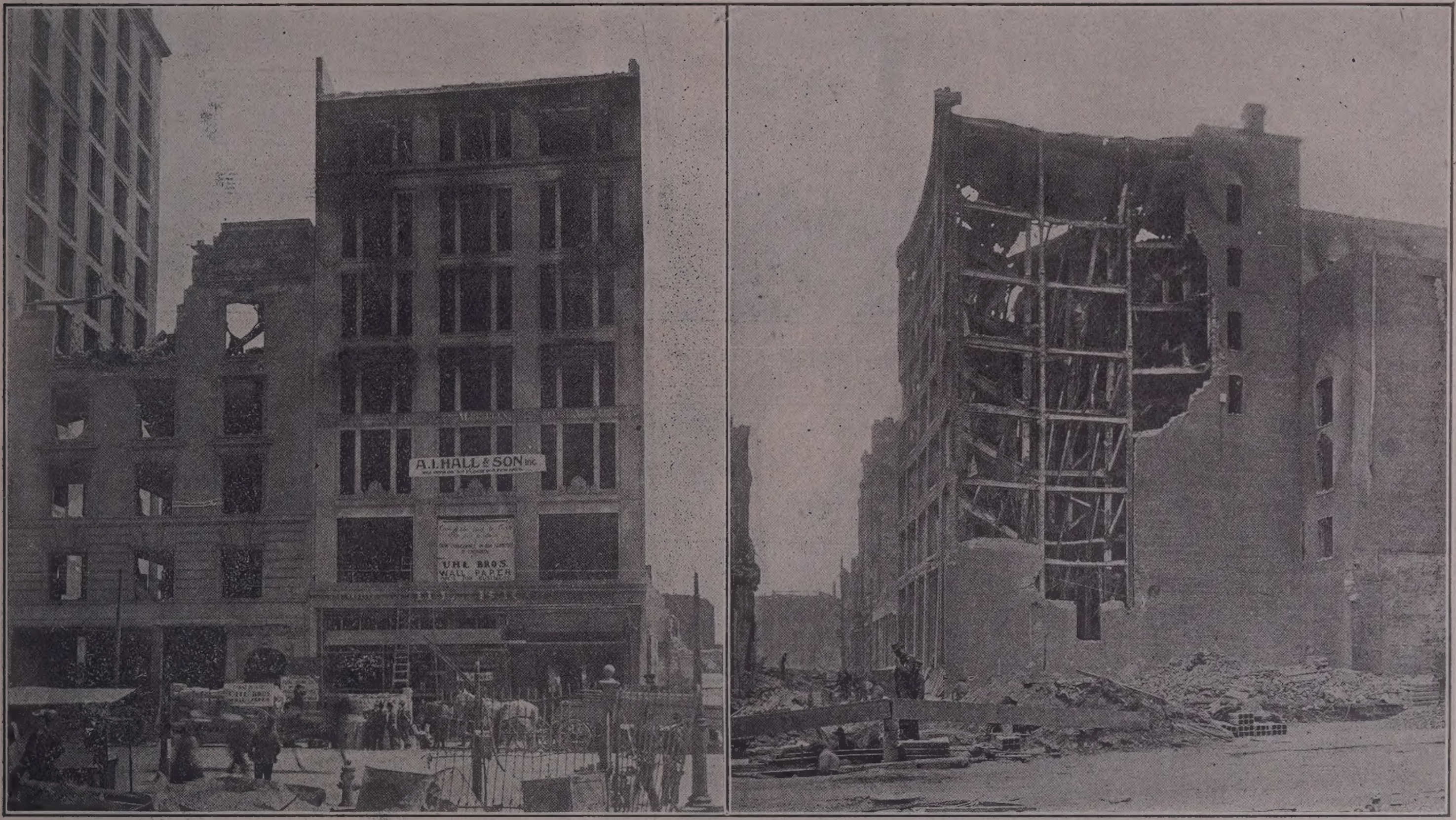
The Stepney and Rotherhithe Tunnel.

About 550 men are now employed by Messrs. Price & Reeves on the construction of the Stepney and Rotherhithe tunnel under the Thames River about a mile and a quarter below the Tower bridge. The tunnel and its approaches are nearly 1⅓ miles long, and the demolition of buildings for the work compelled the London County Council to find quarters for 2,743 disturbed tenants. The work is estimated to cost £2,000,000, half for the tunnel proper and half for land, buildings and compensation. The two open approaches are about a third of a mile long, the cut and cover work is a trifle less than a quarter of a mile, and the tunnel proper is 3,742 ft. in length. It is 27 ft. in diameter inside, 3 ft. more than the Blackwall Tunnel, and will consist of an iron ring lined with concrete and faced with white enameled brick. The roadway will be 16 ft. wide and on each side of it there will be a sidewalk 4 ft. 8 in. wide. About 300 ft. of the subaqueous tunnel has been driven and 200 men are engaged on this part of the work. The minimum cover over the crown of the tunnel is 8 ft. and about 21 lb. air pressure is used during high tide and 13 lb. at low tide.

Notes on the Fireproofing in San Francisco Buildings After the Fire.

By B. B. Holland.

Sellers Building, Market St., near Ferry St.; five stories, with Roebling concrete floor arches, tile partitions and column coverings. The floor is in very good condition as far as looks are concerned, but on careful examination I found the concrete to be very loose and soft. Most of the damage done to this building was by the earthquake. There was not much heat in this building. The tile partitions are all down; the soffit of the girders was not protected and the girders warped considerably. The first floor, protected with a metal ceiling, is still in fairly good condition. Column coverings are in fair condition. In many places where the covering of columns was off the columns are in bad shape.



Front and Rear Views of the Kamm Building.

Hobart Building, Market St., near Montgomery St.; concrete floors, metal ceilings, concrete column coverings. The ceiling is gone, and the girders warped; the first floor of the building is entirely out and the second floor partly out. This is a five-story building and looks to be about a total wreck. The fire in this building was very hot, from all that I could learn.

Postal Telegraph Building, Market St., adjoining Hobart Building; five stories, concrete floors, metal ceiling, tile partitions, concrete covering on columns. The first floor arches are all out; the upper floors look to be in fairly good condition. The ceiling of the first floor is mostly down, and that which is still up is not in good condition and will have to come down. The tile partitions are all down in the lower floors and all loose in the upper floors. The concrete coverings on the columns are all off and the columns and beams badly damaged. There was a very hot fire in this building.

Union Trust Building, Market and Montgomery Sts.; nine stories, with hollow tile arches, partitions and column covering. The arches on the first floor and the partitions were damaged the most. The partitions are all down and the bottoms of the arches are broken off. From what I could learn, most of the damage was done by fire. The column covering is all off on first floor, but the columns were not injured; the upper floors are in fairly good condition. The fire in this building was very hot.

Crocker Building, Market and Montgomery Sts.; ten stories, with arches, partitions and column coverings of hollow tile. The arches in the first and second floors seem to be in fairly good condition, except that the bottoms of the tile arches are broken off to the extent of 50 per cent. In many rooms the partitions are not cracked and the upper floors are in very good condition. The first and second floor column tile in most all cases is down and the partitions are down. The balance of the floors, partitions and columns are standing but seem to be very shaky, although in all cases in these buildings where partitions are down, the tile is not broken, but is in good condition. In this building the fire was very hot. The Pacific Hotel opposite this building, being a building with no fireproofing in it, made a very hot fire, and also made it very hot for the surrounding buildings in this neighborhood.

Old Chronicle Building, Market and Kearney Sts.; ten stories, with tile arches, column covering and partitions. All the floors in this building, except the first and second, seem to be in fairly good condition, but my examination was made from the outside so far as upper stories are concerned. The west section of this building, where the machinery was located, fell and carried all floors to the basement. The bottom of floor arches in the first and second floors was badly damaged by falling off. The column covering is off, but the steel work seems to be in good condition. The partitions are also down in the first and second floors; the balance of the building, from what I could learn, was damaged some, but not to any great extent.

New Chronicle Building, Kearney St.; fifteen stories, tile arches of end construction, partitions and column-covering tile, not yet completed. This had all the floor arches in and the roof on, but was not enclosed. There was not much fire in this building. The first and second floor arches were damaged by the bottom of the arches coming off, about 33⅓ per cent. The column coverings and partitions suffered some. Much of this work was very green.

Monadnock Building, Market St.; ten stories, with concrete arches, metal partitions and ceiling. It was not occupied, and I am informed that it did not get a very hot fire. The ceiling and partitions are down where there was much fire. All the floors in this building seem to be in fairly good condition except the lower.

Mutual Savings Bank: ten stories, with Roebling concrete floors, which are all in very good condition, not much damage having been done to the inside of the building. There was a very hot fire surrounding this building, and the most damage done was to the outside stone wall.

Spreckels or Call Building, Market St.; fifteen stories, outside stone, concrete floors, tile partitions and column protection. There was not very much heat in this building. The lower floors are badly damaged, while the upper floors seem to be in fairly good condition. The partitions and column coverings on the first and second floors are mostly down, but in all cases the steelwork is in good condition.

Emporium Building; six stories, with segmental tile arches, tile partitions and column coverings. The building is a wreck. It was subjected to a very hot fire and was dynamited three times. Where the columns stood the tile arches are still intact.

Flood Building: twelve stories, with tile arches, column coverings and partitions. The metal lath ceiling is all down on the first floor, and also the column coverings and partitions. All other floors in this building seem to be in very good condition. All the woodwork in the different rooms and corridors was burned out, but the partitions are all standing. The building seems to have stood the fire as well as any structure in the city. The first floor seems to have suffered the most.

Hamilton Building; with concrete floor arches and metal partitions. These are all gone where the fire hit them very hard. The column coverings are gone, and the concrete floors are soft and easily broken.

German Savings Bank; with lower floors of concrete and tile arches in upper floors. This building does not seem to be injured much, although subjected to a very hot fire. Very little expense will put it in good repair again.

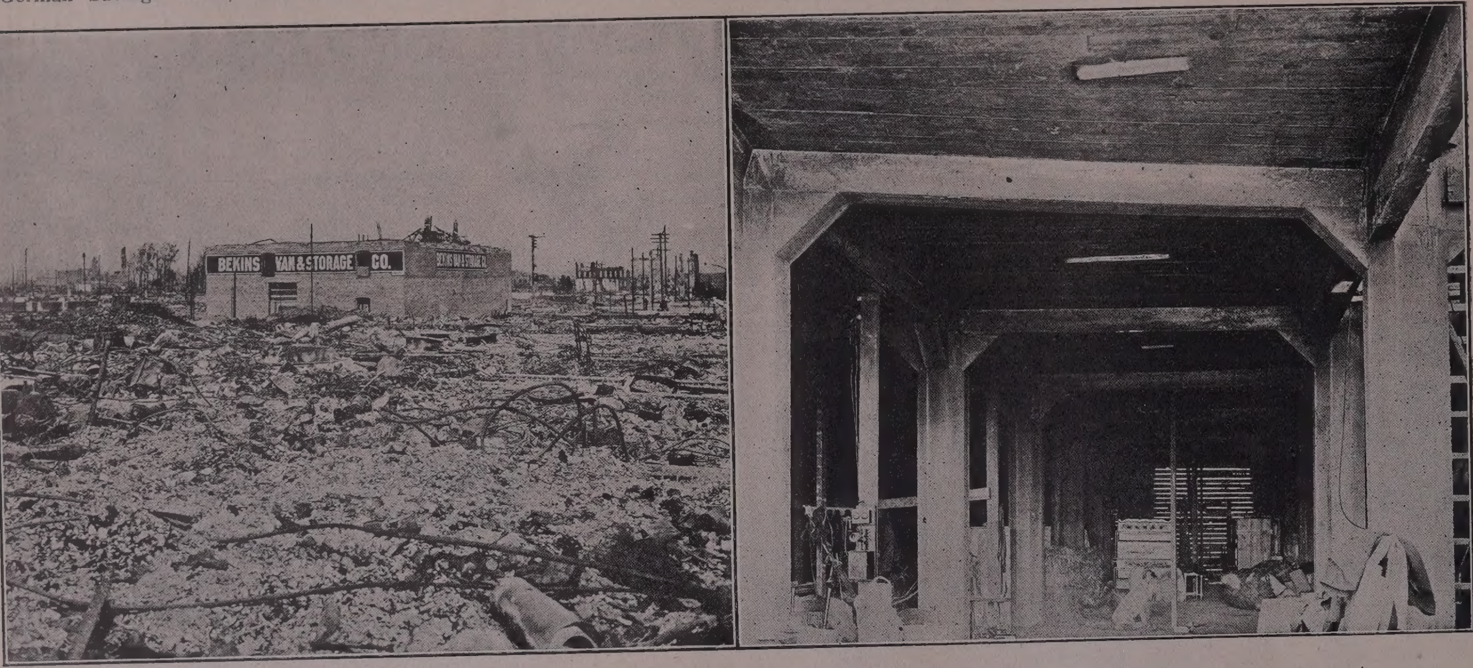
Kohl Building; eleven stories, with Roebling concrete floors. This building did not seem to get much fire. The first, second, third and fourth floors are damaged where fire broke the windows, but in the balance of the building very little damage was done. The upper floors of this building are still occupied. One or two rooms on the first floor have their ceiling down. As the glass in windows of the upper floors was not broken, the fire could not have been very warm around this building.

Merchants' Exchange Building; thirteen stories, with concrete floor arches, partitions and column coverings. This building is in excellent condition. The fire around it was very light, and not much damage was done.

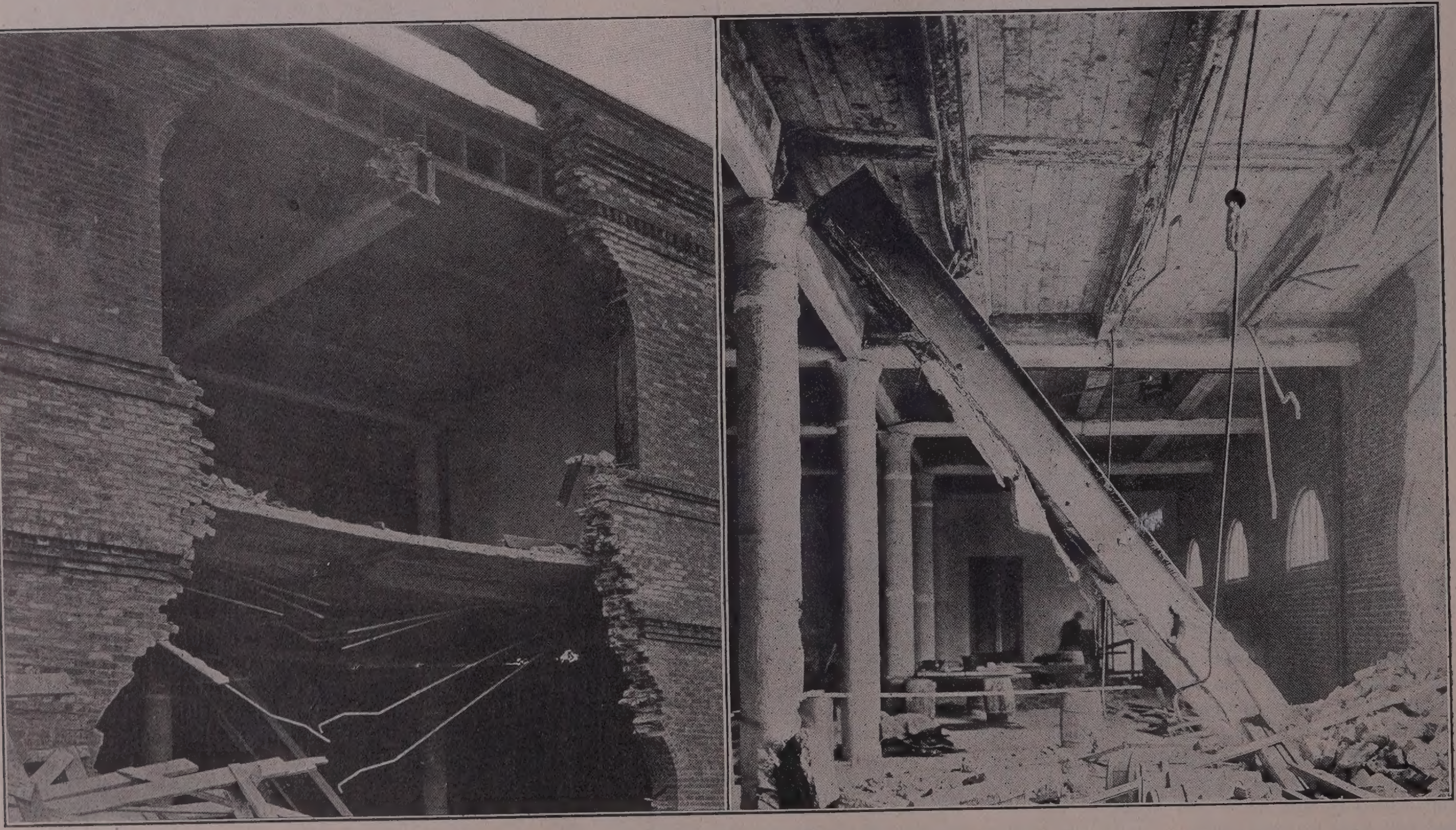
Mutual Insurance Building; eight stories, with tile arches, partitions and column coverings. I examined this building thoroughly from top to bottom and found it in excellent condition. Column coverings, partitions and arches are all good. The only damage done inside is where safes dropped through the upper floors to the basement, taking one section about 20 ft. square out from top to bottom. I was informed by a man connected with the building that the fire was very fierce and hot around it, and the flames entered it through a skylight.

Wells-Fargo Building; with concrete floors and metal lath ceiling. This building is in very good condition, but the plastering in most of the rooms is being taken off. This is about all the damage done to the building, as far as I could see; I was informed that it did not get much fire.

Rialto Building, with 10-ft. "Monolith" floor spaces. This building was dynamited twice, and two-thirds of it is a wreck. One section of the building, about 60x100 ft., is still standing. The floor arches in this section of the building seem to be perfect. I tested the concrete with a pick



Exterior and Interior Views of Bekins Van & Storage Company's Building.



Exterior and Interior Views of Casa Calwa Building, Showing Condition of Concrete Floors.

and found it solid and in good condition. The fire was very hot in this building. The tile partitions are all good, but shaken considerably. Eighteen arches in the first floor appear to be perfect, but the ceiling is all down. The upper floors in this section are all good.

Aronson Building; concrete floors and tile partitions. This building has just been completed and was occupied. The partitions are in very bad shape on account of giving way of lower columns and letting the whole structure down; otherwise it looks to be in very good condition.

Spring Valley Water Building; six stories, with tile arches, partitions and column protection. I understand that the earthquake did most of the damage to this building, although it was subject to a very hot fire. The floors seem to be in very good condition, the first floor being most damaged. The bottoms of the arches on the second floor are off. The columns are in very good condition.

Schreve Building; with Roebling concrete floors and metallic ceiling. The ceiling cracked some and the partitions are mostly down.

Sloan Building; with concrete floors, all down, caused by the giving way of beams and columns. This building was exposed to a very hot fire which, I am informed, did all the damage.

The Ferry Building.

Market Street Bank; with Roebling floor arches and tile partitions, all in very good condition. There was not much fire here.

Mills Building; ten stories, with tile arches, partitions and column protection. The lower floors of this building are damaged, as in all cases, by the lower part of the arches falling off. I should say that the tile work in this building was damaged on the first, second and third floors about 40 per cent. The upper floors seem to be in fairly good condition. The safes on the upper floors broke through in many places. The fire was very hot here.

Globe Mills Warehouse; concrete outside walls 22 in. thick, arches concrete, beams and columns were not protected. I understand from the foreman of the mill that this building was not hurt by the earthquake, but that they were working in it afterward, preparing to protect it from the fire, when the soldiers ran them out and the fire wrecked the building. The floors and arches are all down and the outside walls cracked in many places. All will have to be rebuilt. This firm did not carry any insurance because it thought it had a fireproof building.

Fairmont Hotel; with concrete arches, partitions and column coverings, metal lath ceiling. This building was not yet occupied and not entirely finished; it is a wreck wherever the fire struck it. Partitions are down wherever I was allowed to go; column coverings off, arches warped, columns melted and in some cases buckled wherever uncovered.

St. Francis Hotel; with Roebling concrete floor arches, which were subjected to a very warm fire. Everything is in very good condition in this house.

Both concrete and hollow tile seem to have suffered most damage on the lower floors of all buildings. It is very hard to get correct information regarding the destruction of buildings, as every person seems to have a different story to tell as to what caused the damage, and as to how hot the fire was around any of the buildings. I find that in all cases where the fire was very severe and the concrete covering of columns had come off, the damage to the columns was far greater than where the columns had been covered with hollow tile and the tile had fallen off. It seems the tile stayed on the columns long enough to protect them from the fire, while in the case of the concrete protection the fire seems to have eaten right through and melted the columns in many cases. My examination in all these cases has been as careful as possible. I went over this ground five times and got all the information that I possibly could regarding each building from different individuals.

THE STETTIN-BERLIN CANAL is to be improved. The present waterway between the cities, built in 1746, with 18 antiquated locks, has only water enough for vessels of 170 tons. The course is to be slightly changed, and the canal will have eight locks and will be deepened to enable 600-ton crafts to ply between the cities. The estimated cost is $71,400,000. When the canal is finished Stettin hopes to regain a great portion of the lost trade that has gone to Hamburg and Lubeck, due to their excellent water connections with Berlin.

Coordinate Geometry Applied to Problems in Railroad Alignment.

BY G. L. BILDERBECK.

The idea of locating points and lines by means of their relative positions when referred to a given line or point is a comparatively old one. We recognize it at once as the basis of coordinate geometry; but do not in general endeavor to determine what advantage or disadvantage coordinate geometry has for the solution of practical problems. This form of geometry is usually kept within those branches of mathematics which do not concern the engineer. The cause for this is probably due to the fact that we have become well enough acquainted with the methods and system of reasoning to recognize at a glance their inherent values. It was introduced into the higher branches of mathematics because it is more logical and lends itself to the analysis of all types of solid and plane figures more artistically than trigonometric methods. When we derive a fundamental principle in coordinate geometry we so assume our points and lines that the derivation will be simple. Then it is a fact that the principle will apply as well to the most complicated cases, as to the simple one from which it was derived. A method of this kind would tend to make the solution more routine like; and because it has this tendency it must increase the accuracy of the computer, besides decreasing the probability of error in any particular case. When using the more common trigonometric method each change in the form of any type of problem necessitates going through the analysis separately. This is the element that makes trigonometry peculiarly suitable for mental gymnastics. Indeed, for the solution of problems in the field it becomes like playing chess on limited time. Coordinate geometry is particularly commendable for the solution of problems in alignment, since in a great number of cases the practical problems will afford a general solution, involving but five or six fundamental principles. Knowing that three points determine a circle we may assume three variable points and derive relations that will solve all problems that involve the circle, point and line that will bear a trigonometric solution. If we were to work them out in general terms by means of trigonometric methods the variety and length of our solution would be much greater than that previously stated.

Suppose we review a few of these fundamental principles, although they are familiar to many readers, in order to show their application in railroad work. First assume a set of axes and two variable points P_1, P_2, Fig. 1.

These points are completely expressed with reference to these axes as (x_1, y_1) (x_2, y_2). Then the distance d between these points is

$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

This holds true in whatever position the points are. When the point (x_1, y_1) remains stationary and the point (x_2, y_2) moves so that the distance d is always constant, the point (x_2, y_2) generates a circle in the plane of the axes. When we transfer the origin from the point (O, O) to the point (x_1, y_1) the expression takes a simpler form:

$$x_2^2 + y_2^2 = d^2$$

This is the circumference of a circle with origin at the center.

When the points (x_1, y_1) (x_2, y_2) both become fixed let it be desired to determine the co-ordinates of a third point on the line d passing through these points and produced if necessary. Produce the line d to cut the axis of Y, as shown in Fig. 2. The co-ordinates of this point are (O, b). Then for the point P whose co-ordinates are (x, y) we have the simple relation: $(y - b) \div x = m$, where m is the tangent of the angle the line makes with the axis of X.

Using the fundamental conception of trigonometry, when the line in question rotates about the point (O, b) until the angle it makes with the axis of X becomes greater than 90 deg., the slope m becomes negative. In order to make this automatic we must consider that the distances measured along the axis of Y and above the axis of X are positive and below the axis of X are negative. In the same way distances measured to the right of the axis of Y are positive and to the left are negative. This is the only limiting element that must be constantly borne in mind in the analysis, since a mistake in the sign of an ordinate introduces an error in the final result.

In the form last derived we may express the value of m and b in the terms of $(x_1\ y_1)\ (x_2\ y_2)$, thus:

$$m = (y_2 - y_1) \,/\, (x_2 - x_1)$$
$$b = x_2\,(y_1 - x_1\,y_2) \,/\, (x_2 - x_1)$$

Assume a set of co-ordinate axes as before and a line passing through the origin. Call it line 1. Suppose it is desired to express a line perpendicular to and intersecting line 1 at a point situated a distance d from the origin. Line 2 expressed in general terms will be

$$y = m_2\,x + b.$$

If the line is through the point (x_3, y_3) this will become

$$y_3 = m_2\,x_3 + \mathrm{b}.$$

Also we have

$$x_3^2 + y_3^2 = d^2.$$

Eliminating y_3 between these, there results,

$$x_3^2\,(1 + m_2^2) + 2\,bm_2\,x_3 + b - d^2 = 0.$$

This is a quadratic in x_3, but we know that both values of x_3 must be equal, since the intersection is that of a straight line.

$$m_2^2\,b^2 - (1 + m_2^2)\,(b^2 - d^2) = 0.$$
$$b = \pm\,d\,\sqrt{1 + m_2^2}$$

There results for the final form then

$$y = m_2\,x \pm d\,\sqrt{1 + m_2^2}$$

It is possible to get the expression for line 2 in a form involving the values of (x_3, y_3) directly. If m_1 is the slope of line $m_2 = -1/m_1$

(1) Then $(y - y_3) = \dfrac{x_3}{y_3}\,(x - x_3)$

Therefore $x\,x_3 + y\,y_3 = d^2$.

It will be noticed from the data given that line 2 is tangent to the circle generated when line 1 rotates about the origin as a center with a radius d. We might go on multiplying derivations as long as we please, but should find that all conclusions drawn involving only the line and circle would be directly based on the principles already shown.

Using these principles let us investigate some of the typical railroad alignment problems.

Assume the condition shown in Fig. 3. When the center of the circular curve is the origin the forward tangent will be given by the relation

$$y = mx \pm r\,\sqrt{1 + m^2}$$

or $y = mx = r \operatorname{cosec} D$, where m is the tangent of the angle that the forward tangent makes with the X axis $= 90° - D$.

When referred to the $P.\ C.$ as the origin the equation becomes

(1) $y = m\,(x + r) \pm r\,\sqrt{1 + m^2}$
(2) $y = m\,(x + r) \pm r \operatorname{cosec} D$.

These relations express the forward tangent in terms of the radius and angle D at the center as constants and also refers it to the $P.\ C.$ as the origin.

(1) Suppose it is desired to find the new radius r_1 such that the curve will pass through the point P_1T_1 which is a point b distant from PT parallel to the back tangent. The ordinates may be found quickly and are:

$$y_1 = r \sin D + b$$

$$x_1 = r - r \cos D = r \sec D.$$

When m is kept constant there results by substituting in equation (2)

$$\frac{r\,(\sin D - m \sec D) + b}{m \pm \csc D} = r'$$

If it is desired to change the direction of the forward tangent by a given amount, it can be done with the same formula, since it involves the slope of the forward tangent in general terms.

By using equation (1) and assuming any point in the field it is at once possible to find r when m is given or m when r is given.

(2) Suppose we are given the degree of curve and an external point; it is required to project the tangent through that external point. It is necessary to know the location of the external point referred to the $P.C.$ as above. With these data we have the relation

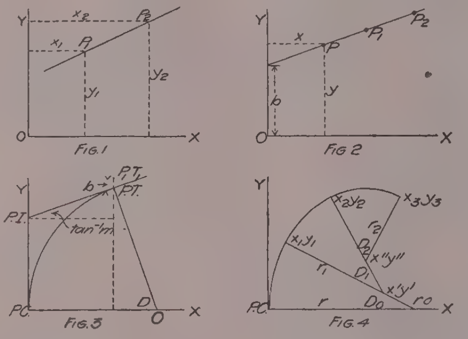


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Railway Curves by Co-ordinate Geometry.

$$y_1 = m\,(x_1 + r) \pm r\,\sqrt{1 + m^2},$$

in which (x_1, y_1) are the co-ordinates of the external point, and r is the radius of the curve, all given. In this m, the slope of the forward tangent, is the unknown quantity. Knowing m we can get the angle D directly. A farther consideration of these equations will show that it is possible to shift both tangents in either direction parallel to their initial position, and find the corresponding radius r; or shift the back tangent parallel to its initial position and change the direction of the forward tangent a given amount and find likewise the corresponding r. These two equations applied in this way will solve nearly all cases that will arise involving the simple curve.

Let it be desired to run in a curve that shall change its curvature a given amount for each station of advance along the curve from the back tangent. That is, for the first stated length it shall have a degree of curvature n, and for each other as we advance along the curve it shall, for instance, have a degree $(n + 1)$, $(n + 2)$, $(n + 3)$, etc.

The successive points on the curve, Fig. 4, are represented by $(x_1, y_1)\ (x_2, y_2)\ (x_3, y_3)$. Those representing the centers of the successive arcs ....$(O, r)\ (x', y')\ (x, y)\ (x'', y'')$........ The successive radii r, r_1, r_2, ... The angles subtending the successive arcs will be known; call them D_0, D_1, D_2, etc. The co-ordinates $(x', y')\ (x'', y'')$ .... may be found directly.

$$x' = r - (r - r_1) \cos D_0.$$
$$y' = (r - r_1) \sin D_0.$$
$$x'' = x' - (r_1 - r_2) \cos (D_0 + D_1).$$
$$y'' = y' + (r_1 - r_2) \sin (D_0 + D_1).$$
$$y''' = y'' + (r_2 - r_3) \sin (D_0 + D_1 + D_2).$$
$$x''' = x'' - (r_2 - r_3) \cos (D_0 + D_1 + D_2).$$

The co-ordinates of P are not needed, those of P_1 may be computed. Let the slope of the radii be m, m_1, etc., $= \tan D_0, \tan (D_0 + D_1)$ etc............

$$(x'' - x_2)^2 + (y'' - y_2)^2 = r_2^2$$
$$m_1\,(x'' - x_2) = (y'' - y_2)$$

$$x_2 = \pm\frac{r_2}{\sqrt{1 + m_1^2}} + x'' = r \cos (D_0 + D_1)$$

$$y_2 = \pm\frac{r_2\,m_1}{\sqrt{1 + m^2}} + y'' = r \sin (D_0 + D_1)$$

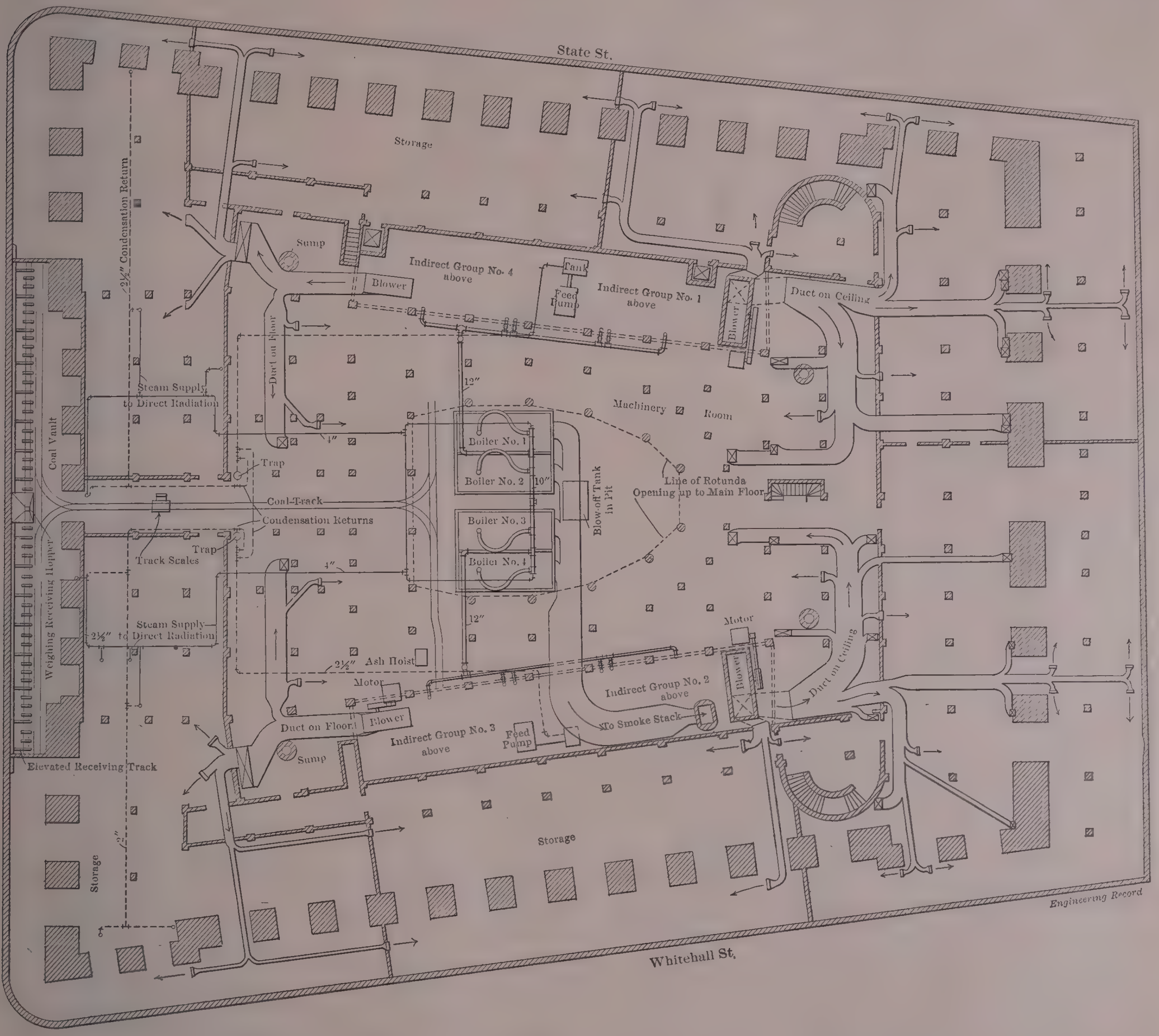
The ordinates will take symmetrical formulas for any number of stations or any length of curves. When the angles D are all equally small, so as to give chords of 25, 50 or 100 ft. in length, the curve is an easement, and when they are made large it is a compound curve. The deflections from the P.C. for any point on these curves may be found since the tangent of deflection is equal to x/y. The location of the ordinates for points of change in curvature, etc., will in general be the method of attacking any compound curve problem. Having located these, either specifically or in general terms, the method of procedure for adapting the equations to given conditions will be evident, à priori.

By the method of co-ordinate geometry the amount of work involved in the solution of any problem depends largely upon the point where the origin is selected. If this is chosen judiciously the amount of work will be reduced to a minimum. It is impossible to give any definite rule that will hold in all cases. The best procedure is to consider first those points which are common to most of the lines and curves involved in the problem at hand. These points should be considered first since for a curve to pass through the origin is to simplify its equation. The idea is the same as that which we use in mechanical problems for selecting the origin of moments so that as many of the unknown forces as possible shall have their lines of action pass through the origin.

The Permeability of Concrete Blocks has been so long regarded as one of their greatest disadvantages that it is interesting to observe how well it can be cured by the use of what is known as the Medusa water-proofing compound. In some tests of blocks made of 1 part cement and 4.8 parts of limestone screenings and then weathered for nine months, it was found that the absorption of water was reduced 77 to 84 per cent. by adding 1 per cent. by weight of the compound to the cement, and when 2 per cent. was added the absorption was reduced 81 to 86 per cent. The tests were made by placing the blocks in 2 in. of water and weighing them at the end of 1, 2, 3, 4 and 24 hours. The increase in the absorption between the determinations made at 1 hour and 24 hours was only 7 per cent. of the weight of the blocks when 1 per cent. of the compound was used and 3 per cent. when twice as much of the water-proofing was employed. These results are much superior to those obtained with other methods of waterproofing; particularly when it is considered that the concrete of the blocks is the porous dry-mixed material which alone can be used in block machines. It is well known among concrete specialists that dense concrete can only be obtained by using a degree of care in balancing the sand and proportioning the ingredients, which is not customary among concrete block makers, and alum and soap washes are bothersome.

Heating and Ventilating System of the New Custom House in New York.

The new United States Custom House under construction in New York is a large seven-story granite and steel structure occupying the entire block facing Bowling Green Park at the foot of Broadway, and bounded by Whitehall, Bridge and State Sts. It occupies a plot 300 ft. in length, 200 ft. in width at the Bowling Green front, and 280 ft. in width on Bridge St. at the rear. It has a large interior court, approximately 100 x 150 ft. in size, which has in it an oval domed rotunda rising to the second-story level which is devoted to offices on the first and second floors. The Bowling Green front is 72 ft. in width, the two side wings 65 ft., and the rear portion on Bridge St. 50 ft. The front and side divisions are devoted to offices. The rear division, the basement and first floors of which are used for a branch Post Office, is but three stories in height. The basement and sub-basement are devoted to offices and storage purposes, with the exception of the portion beneath the rotunda in which the boiler plant and the heating and ventilating equipment are installed.



Mechanical Equipment in the Subbasement of the New Custom House at New York.

The indirect heating system is used except in the portion to be devoted to Post Office purposes, where auxiliary direct radiation is installed for heating at night when the main ventilating system is shut down. The corridors are to be heated by a secondary utilization of the air after it has passed through the offices and rooms of the building, and will thus serve, with the elevator shafts, as vent outlets for all rooms heated. The ventilation will be accomplished by natural draft through special vent shafts, which will remove air from the corridors and elevator shafts, mechanical ventilation being provided only for the toilet rooms. The special features of the installation are the use of air-washing apparatus, the method of avoiding back drafts to the rooms adopted in connection with the combination corridor heating and exhaust system, and also the method of preventing cool drafts from the large window exposures in certain rooms, particularly the rotunda. Steam is furnished directly at low pressure from the boiler plant, there being no plant from which to obtain exhaust steam for the heating system.

On account of the size of the building the heating and ventilating system was for convenience divided into four independent divisions, each serving a section of the building adjacent to one corner. Each division has an independent blower and duct system, with an intake in the central court in the area surrounding the rotunda structure, the space occupied by this equipment together with the air-washing apparatus, tempering and reheating coils, and ductwork, for each quarter section, comprising an area of about 25 x 60 ft. in the sub-basement and extending up through the basement. This apparatus has been installed in two double groups of two equipments each, one upon either side of the boiler room, by which arrangement the two blowers of either group each draw air from the same intake opening into the areaway surrounding the rotunda. The double groups, which are located beneath the side sections or wings of the structure, together occupy a total space of 25 x 120 ft. each; that under the State St. wing comprises heating group No. 1, which supplies the northwest corner, and group No. 4, supplying the southwest corner of the building, while the installation upon the Whitehall St. side consists of heating groups Nos. 2 and 3, which supply the northeast and southeast corners of the building respectively.

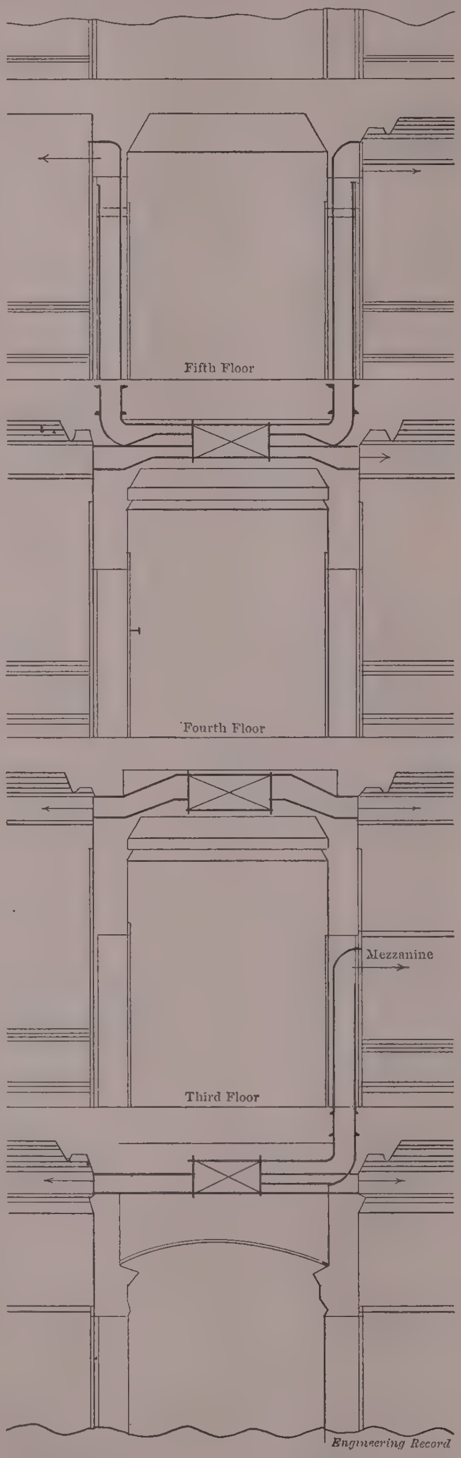
The arrangement of apparatus in one of the double groups is shown in an accompanying detail plan. It comprises a large intake chamber in the middle with tempering coils on either side, beyond which are, in the order named, the air-washing equipments, the reheating coils and the blowers which connect directly to the distribution ductwork. The arrangement is compact, the tempering coils and air-wash apparatus being in either case located practically within the fresh-air intake chamber, which is 22 x 45 ft. in plan and 12 ft. high. These chambers have three inlet windows which open out into the court areaway surrounding the rotunda at the basement level and provide a combined intake area of 180 sq. ft.; this serves the two blowers upon either side, each of which has a capacity of 100,000 cu. ft. of air per minute. The tempering coils of each system have 5,850 ft. of 1-in. pipe, a heating surface of 2,017 sq. ft., which is merely used in raising the entering air to a temperature above the freezing point before entering the water spray of the air-washing system in order to prevent freezing at the sprays.

The air-washing apparatus for each system consists of a spray chamber in which the air is drawn through a series of water sprays for the purpose of cleansing it of impurities and at the same time regulating its humidity. A drying chamber or separator between the spray and the fan intake prevents the water being carried mechanically into the fan and delivered to the duct system. In the spray chamber there are four horizontal rows of spray nozzles located 24 in. apart, each row consisting of eleven nozzles similarly spaced upon a horizontal supply pipe, so that there are 44 nozzles in all in each chamber. This chamber has a cross-sectional area at the spray point of 9 x 22 ft., so that the air velocity through the spray at maximum delivery of the blower is but 500 ft. per minute. The nozzles have ¾-in. connections to the 1½-in. pipes supplying them and each is designed to deliver ¼ gal. of water per minute in a fine spray when supplied at a pressure of 15 lb.

The water for the sprays is used over and over continuously until it becomes dirty, when it is drawn off and replaced by fresh water. There is at the bottom of each spray chamber a large pan or tank, 2 ft. deep, 8 ft. in width and 22 ft. long, extending across the duct, which serves to receive the drainage from the spray nozzles and from the eliminator baffle plates. This tank is of steel plate construction braced with angle irons and has an inclined apron to catch the spray that is carried forward by the moving air. From this it is pumped through a series of strainers by a 4x5-in. triplex motor-driven pump to the spray supply lines, one pump serving for both air-wash sprays at each intake chamber. Two 4-in. outlet connections from the two spray pans join in a 4½-in. suction connection to the spray pump, which returns the water through a 4-in. supply main with 3-in. branches to either spray pipe manifold from which are supplied the nozzle headers of 1½-in pipe decreasing gradually to ¾ in. at the ends.

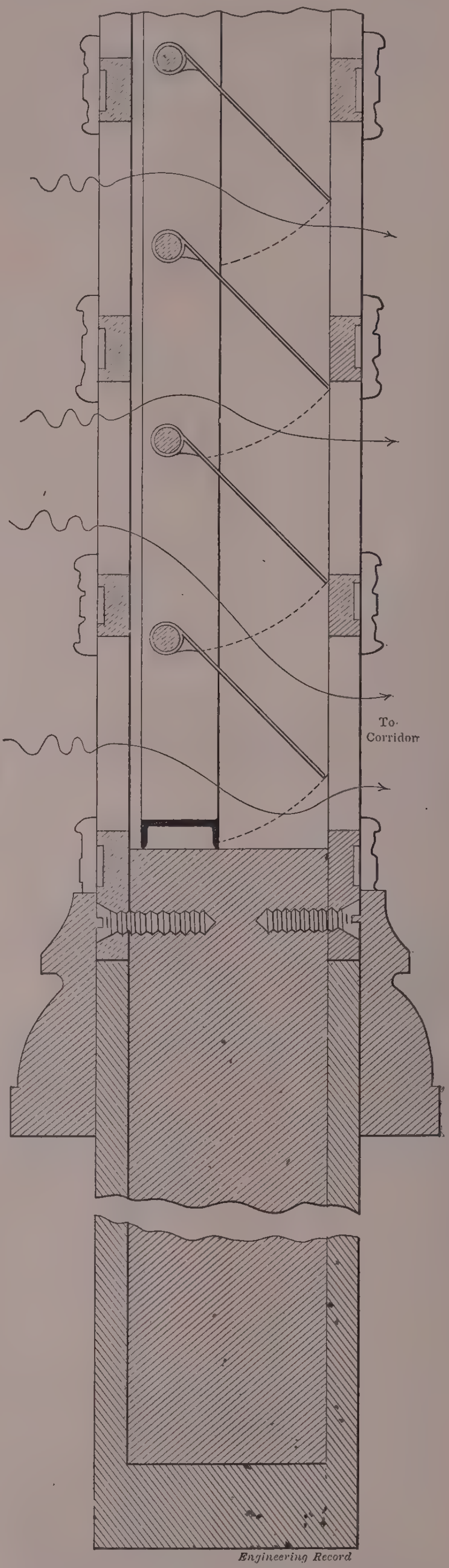
The dry-chamber portion of the air-wash equipment consists of series of inclined baffle plates between which the air must pass in zigzag courses before entering the blower, so that the particles of entrained water are thrown into contact with the plates and thus prevented from being carried mechanically into fan and duct system. These baffles, which are spaced 18 in. apart, consist of vertical strips of No. 20 galvanized iron, 12 in. in width, supported at the top and bottom edges only. On their edges toward the blower intake, there are riveted 1¼-in. galvanized angles which serve as cupped edges introducing a centrifugal separation effect and effectively catching particles of water carried with the air. The dry chamber is enlarged to 10 x 22 ft. in cross section for a slightly reduced velocity of the air in passing the baffles.

A feature of this plant differing from many others is that the air passes through the reheating coils and is brought to the desired delivery temperature before entering the fan, which arrangement, owing to limiting conditions in the fan room, proved most convenient. Systems 1 and 2, located at the Bowling Green end of the building, are equipped with 16 section heaters which have each 14,128 ft. of 1-in. pipe, equivalent to a heating surface of 4,872 sq. ft. Equipments 3 and 4, which supply the Bridge St. sections at the rear, have reheater coils of 12 sections each, containing 13,671 lin. ft. of 1-in. pipe, equivalent to a heating surface of 4,714 sq. ft. These reheater coils have been installed in a staggered arrangement and in all systems they are connected up in four supply sections, each of which is controlled by an individual thermostat so that variable settings are possible. These settings are graduated, the first being set to open at a temperature of about 65° F., outside temperature, while the others are arranged in a descending scale so that all are open to the full extent at a temperature of about 40° F. The heating coils were supplied, together with the blowers, by the B. F. Sturtevant Co.



Arrangement of Corridor Supply Ducts.

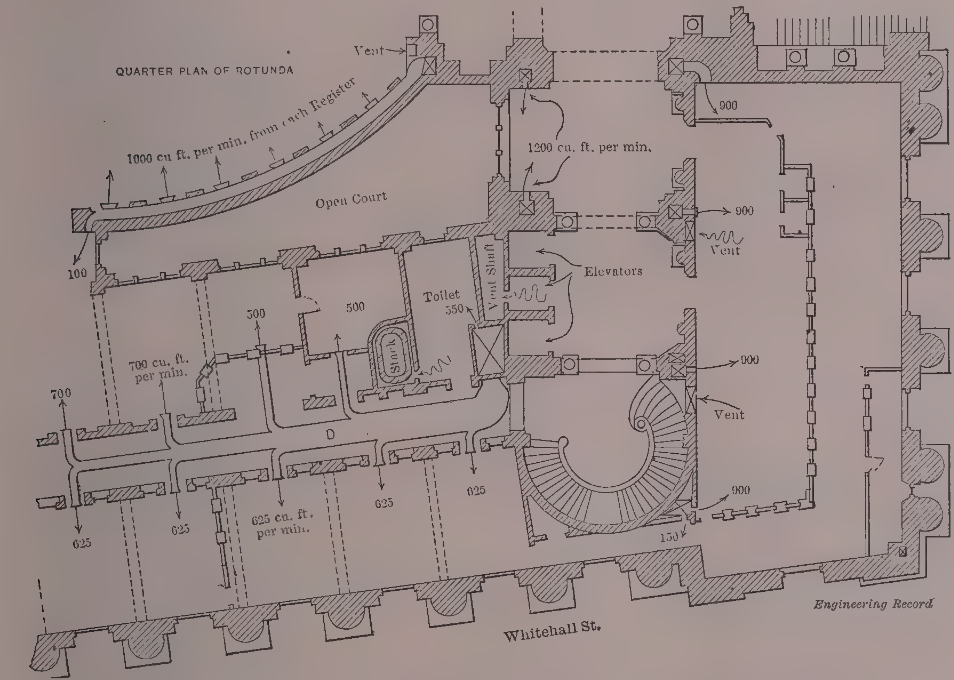
The blowers are all three-quarter housed, peripheral discharge, steel-plate fans, with 12-ft. wheels 6 ft. in width, and have capacities of 100,000 cu. ft. of air per min. at 140 r.p.m. They are belt driven by 50-h.p. Sprague direct-current motors, with 50 per cent. speed variations, furnished with current from the street mains of the Edison system. The delivery connections of the blowers are in all cases 72 x 84 in. in cross-section, blowers 1 and 2, having up-blast connections leading vertically upwards to the fresh air risers, with side branches to the basements,



Automatic Dampers in Door Registers.

while blowers 3 and 4 have 45 deg. downward outlets and duct work connections some 40 ft. in length in the sub-basement, extending to the rear to the riser ducts.

The riser ducts for the various systems have been carried up very close to the inner corner of the sections served, and from these risers, the branch mains supplying the various floors are taken off. The general scheme of supply to the rooms heated is on the downward system, the outlet registers at the ceiling being supplied from the branch ducts, which are in most cases concealed in furred spaces above the ceilings of the corridors, as indicated in the accompanying drawing of a typical corridor section. This arrangement is used throughout for the side wings of the building, but was prohibited in the front wing on account of the desire to avoid furred construction there for architectural reasons. It was accordingly necessary at this place to provide for a number of individual riser ducts alongside of the walls in this division, which risers are supplied from systems 1 and 2, as shown in the sub-basement plan. These risers are of varying sizes according to the rooms to be supplied, and are in all cases concealed by furring on the side walls. Special arrangements of fresh air supply connections were provided also in the sub-basement to provide for ventilation in the spaces beneath the salewalks and storage rooms.



Quarter Plan of Second Floor, Showing Supply Connections.

Each wing of the building has ten bays or sections, corresponding to the spaces between pilasters and columns, and each section has a single outside window and a single door in the corridor partition; thus the division of the interior space of the wing into rooms of differing sizes is only a matter of arranging cross partitions to suit the requirements. The smallest individual office that is possible is 16 ft. wide, the distance between pilasters, while larger ones may be in any multiple of this width up to the full size of an entire side section, 175 ft. in length. The heating system has been similarly sub-divided with individual connections to each of the sections of a capacity sufficient to supply each particular section alone if it were partitioned off from the others. This arrangement renders it possible to make any desired changes in the offices at any future time without necessitating any rearrangement whatsoever of the heating duct connections, and still the entire wing will be amply heated with any rearrangement of rooms that may be desired.

The arrangement of the branch distributing ducts for each of the corner risers is shown in the accompanying second-floor plan which, outside of the rotunda, is typical of the upper floors. On this floor and all others except the fifth, the branch distributing ducts for the supply of the side rooms are concealed in furring above the corridor ceiling; upon the fifth floor, owing to a desire to avoid furred construction, the rooms are supplied by the fourth floor distribution duct, from which branch risers are carried up through the corridor partitions to the supply registers. The outlet branches from the distributing ducts vary from 10 x 12 in. to 14 x 18 in. in size and end in register openings 12 x 20 in. to 12 x 28 in. in size for delivery velocities of from 250 to 300 ft .per minute; these branches are in all cases near the ceiling for downward ventilation. The supplies to the various bays are designed for 300 to 700 cu. ft. per minute, according to the height and exposures of the room supplied, the velocities in branch ducts ranging from 350 to 450 ft. per min., averaging 400 ft. per min. The supply registers are in all cases located as near as possible to the ceiling, in many instances through the cornices, but the corridor supply registers, which serve as vents from the side rooms are located in most cases in the lower panels of the doors, and in all cases within 12 in. of the floor line.

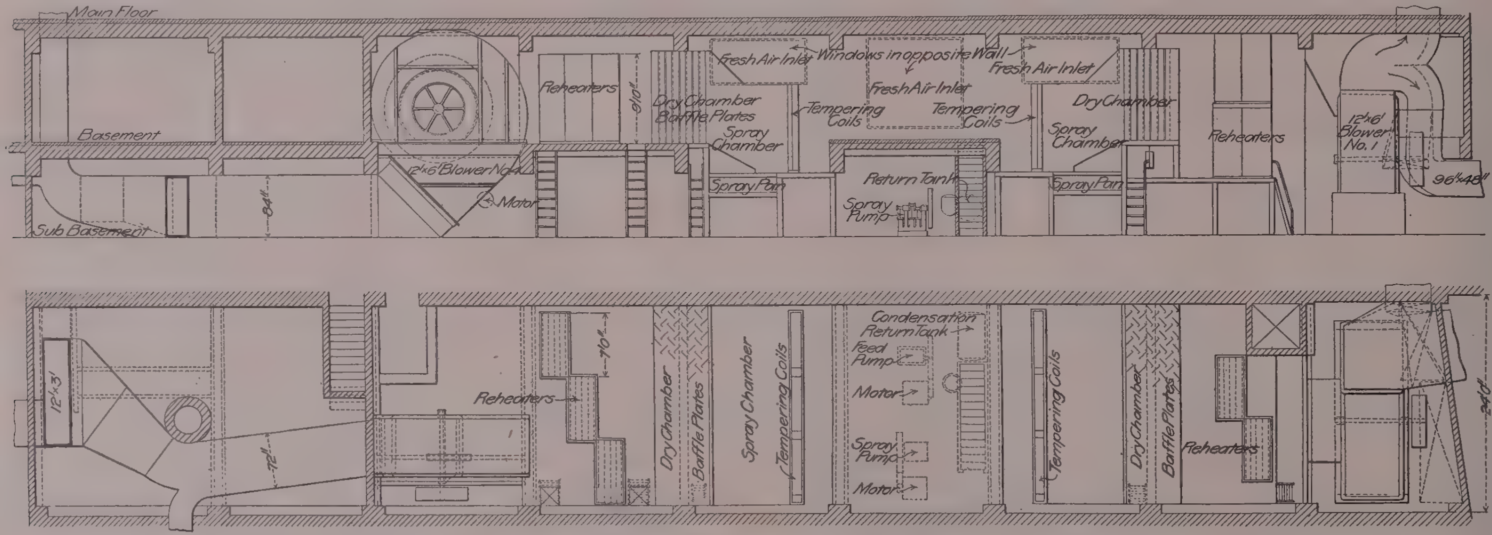
The ventilation of the rooms and offices is in practically all cases accomplished by the door-panel registers, the warm air from them serving for secondary heating. The vent registers in the base panels of the doors are of fancy grilled designs, 14 x 24 in. in size for all doors upon the second and third floors and 12 x 24 in. upon all other floors. They are double-face registers with spaces between the faces of 1½ in., in which are fitted automatic flap dampers for the prevention of back drafts from the corridors into the rooms. These dampers consist of mica leaf flaps pivoted on light steel rods so as to open freely as the air passes outward into the corridor, but to close automatically in case of a counter-current. In rooms where it was inconvenient to vent through doors into the corridors, outlet ducts have been located in the partition walls which take air from the rooms near the floor level and deliver it to the corridors at heights of from 4 to 6 ft. above the floor, flap dampers of similar design being used in their outlet registers. In still other cases where it was found impossible to vent the rooms into corridors, there are small vent registers in the window sashes so as to deliver out-doors. The vent registers of this type are 2½ x 10 in. in size, two of which are located in the bottom member of the lower sash and are similarly provided with flap dampers to prevent back drafts.

In the large office room forming the second floor of the rotunda a special feature has been incorporated in the heating supply connections for the prevention of cool drafts due to the effect of window glass. This room has unusual amounts of glass, the cooling effect of which cannot be sufficiently counteracted entirely by the arrangement of hot air supply, as the latter is furnished by a number of 12x60-in. registers located near the ceiling which thus deliver radially inward toward the center of the room. Accordingly at the base of each window having a north or west exposure, there are special window-sill registers arranged to discharge vertically upwards along the window faces for the purpose of counteracting disagreeable local drafts. These register openings, the connections to which are shown in an accompanying window section, consist of 10x60-in. registers in the window stool which are supplied by a 4x28-in. connection from the supply duct concealed in the ceiling below. At the base of the 10x60-in. outlet connection to the registers, there is an auxiliary opening to a 6x60-in. outlet between this register and the window, the purpose of which is to act by syphonage to draw downward the cool currents of air set up on the face of the window glass and by intermixture with the hot-blast to prevent the communication of cool drafts into the room. It is calculated that in zero weather when air is delivered by the heating system at 160° F., that with the most extreme conditions of window leakage and cooling effect of the glass surface, the delivery temperature from the register will not be less than 65° to 70° F., which is expected to produce conditions comfortable to the occupants of the room.

In the ventilation of the building through the corridors, the air is removed by four large stacks at the rear of the elevator shafts in the four corners of the building. Those back of the rear elevators are 2½ x 14 ft. in section, while those at the rear of the elevators in the front corridors are of an irregular section 11 ft. long and averaging 4 ft. in width. These vent risers have openings into the elevator shafts at every floor which are calculated to be of sufficient capacity to remove an amount of air from its section of that floor corresponding to the amount supplied to it. While it is probable that large portions of the air vented will travel upwards through the elevator shafts, the numerous openings from the elevator shafts into the vent risers will serve to distribute and equalize the flow so that excessive drafts in the upper portions of the shafts will be avoided. Natural draft is to be depended upon entirely in these vent risers which, owing to the forced fresh air supply, will be entirely sufficient. Each of these vent risers opens into a pent house on the roof, which is much larger in plan than the cross-section of the shaft, from which the air passes out through window openings upon all sides. These outlet windows are fitted with automatic flap dampers, similar in design to those referred to in the corridor doors, for the prevention of back draft; in case of wind from any direction the flap dampers on the windward side will automatically close and be held shut by the pressure of the wind, while those upon the leeward side will vent freely.

Mechanical ventilation has been provided for the toilet rooms, there being groups of toilets near the elevator shafts upon nearly every floor. For this purpose there are vent riser ducts at each corner near the elevator locations, into which the toilet room vents open. At one of the front corners, the shaft enclosing the smoke stack is utilized for venting the toilet rooms in that section, the heat of the stack being effective in creating a strong natural draft. This vent riser is, however, like those from the other toilet vents, connected at the roof to Blackman disc exhaust fans in the penthouses. The exhausts from these fans are carried by duct connections out to exhaust hoods upon the roof and thus kept entirely independent of the corridor exhausts through the penthouses.

The auxiliary direct radiation system in the section of the building devoted to the post-office department, which is to be used only when the indirect equipments are shut down, is a single-pipe system having separate returns carried back to the two condensation tanks of the main heating system. This system is applied to the entire first floor of the Bridge St. division of the building, 44 x 260 ft. in size, and a portion of the basement beneath, 90 ft. in length. Low-pressure steam is supplied to the radiation directly from the boilers by two 4-in. steam mains from the steam header in the boiler room, each of which serves half of this equipment. These mains are distributed upon the sub-basement and basement ceilings with individual connections to the radiators upon the floors above, as indicated in the plan. This direct radiation is all located beneath windows and is automatically controlled through special thermostats which throw the radiators into service when the indirect system is shut down. The return system consists of mains paralleling the supply lines on either side and with 1½-in. connections to drip points in the steam supply main, for the return of condensation to the traps in the boiler room. Each return main has an independent trap and both are bypassed as well as interconnected, so that either one may operate on the other main. Each trap delivers through a separate 2½-in. line which joins the returns from the groups of indirect heating equipment upon either side of the building and leads to the condensation pumps. There are two of the latter, which are 4 x 5 in. triplex double-acting vertical pumps, driven through silent chain drives by electric motors, the purpose of which is to return the condensation directly to the boilers; they are designed to return 65 gal. per minute against a boiler pressure of 125 lb. when operating at 50 r.p.m., although the boiler pressure will not exceed 35 lb. under present conditions of operation.



Details of Indirect Supply Equipment for One-Half of Building.

Automatic temperature regulation has been applied to all heating coils of the indirect systems, to nearly all outlets of the indirect heating supply in rooms and corridors, and also to the direct radiation in the post office department, which is operative only when the indirect system is closed down at night. The Powers system of thermostatic control is used, embracing about 400 thermostats distributed throughout the building, from which the radiation supply valves and outlet dampers are operated pneumatically. Both the plain graduated movement and compound thermostats are used, the compressed air supply for which is distributed by a system of galvanized iron piping from the storage tank in the engine room; with branches of ⅛-in. double armored lead tubing to the thermostats and thence to the valve and damper motors. The system is operated with an air pressure of 15 lb., which is maintained by a small motor-driven air-compressor with automatic control.

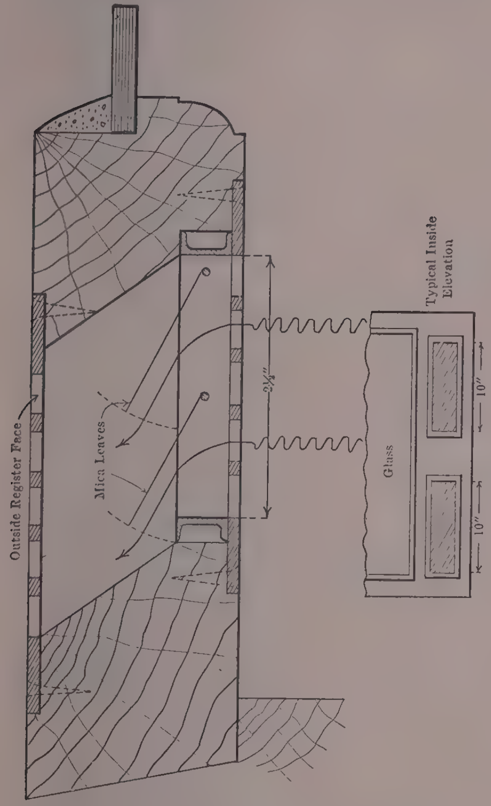
The tempering coils of the indirect systems are controlled by means of cold-air thermostats located in the intake chamber, which method of control is also applied to the four coil sections of the reheaters. The control system is so designed that the number of sections in service is at all times governed by the outside weather conditions and thus does not require the attention of the engineer. The adjustment is such that with an outside temperature below 70° F. one section is in service, when below 55° F. two sections, and when below 35° F. all four of the reheater sections will be supplied with steam. The thermostats operating the automatic steam valves on the supply connections to the coils are of a special type by which the usual graduated movement feature of the Powers thermostat is converted to the positive movement necessary for the control of such valves. The thermostats distributed throughout the building to operate upon the indirect heating sources are of the standard Powers graduated type, operating these dampers with a mixing movement, opening them entirely or closing them entirely only at extremes of temperature. Under ordinary heating conditions they place the dampers in a partially closed position, delivering just sufficient heated air to the rooms to maintain the desired temperature with, of course, a constant amount of ventilation. The mixing dampers in the various rooms are located behind the register faces while the damper-operating motors are placed upon the register faces, with link connections to the damper leaves. The controlling thermostats are located in convenient positions upon side walls about 5 ft. from the floor line, where they will be subjected only to average temperature conditions.

An interesting double type of thermostatic control was necessary in the post office department on account of the two independent heating systems installed there. To properly control both heat sources in these rooms, the Powers compound thermostats are used, which have both the positive and the graduated connections necessary for the control of direct radiators and the indirect supply dampers. The operative point of these compound thermostats for the indirect system is adjusted at a point slightly higher than that for the control of the direct radiators, the result of which is that while the indirect system is used throughout the day, the direct radiators will remain closed off, but when at any time the indirect system might be incapable of heating these rooms, or when it is not in service as at night, the direct radiators are then automatically thrown into service.

Steam is supplied to the heating system by a boiler plant, consisting of two batteries of two 300-h.p. Heine boilers each, designed to carry pressures of 125 lb. for the operation of a power plant if it be desired at any future time to install such an equipment. At the present, however, they are operated as low-pressure equipments only, delivering at 30 lb. directly to the heating system. The boilers are of the inclined water-tube type with two 48-in. drums 13 ft. long and each has 160 4-in. tubes 14 ft. long. The boilers have brick settings with flush fronts and are fitted with plain grates for hand firing. Each delivers through 8-in. outlets with automatic non-return stop valves to a 10-in. steam header over the boiler fronts, from which the 4-in. supply mains to the direct radiation are taken off from either end. Near the ends 12-in. branches are also taken to the heating coils of the indirect groups upon either side. This main has blank connections to permit future connections to further steam-using machinery. Each boiler has two blow-off connections from the mud drum, each of 2-in. brass piping, which connect by a 3-in. line to a blow-off tank, 4 ft. in diameter by 6 ft. long, located in a special steel-lined pit at the rear of the boilers. This tank is vented to the atmosphere by a 4-in. vent riser to the roof and water is removed by an automatically controlled steam pump, delivering to the sewer at a higher level. This tank is fitted with a special cooling coil consisting of 60 ft. of 2½-in. brass pipe through which feed water is delivered to the boiler for preheating and consequent cooling of the blow-off discharge.

The boilers are fed normally by the condensation return pumps above referred to in connection with the return system from the radiation equipment, which consists of two Goulds double-acting triplex motor-driven pumps with 4x5-in. cylinders designed to feed against 125 lb. pressure. These are supplemented, however, by a duplex Worthington boiler feed pump of similar capacity in reserve, and four 1½-in. injectors, one upon each boiler, for auxiliary and testing purposes. The feed piping consists of a 4-in. brass pipe header extending along the boiler fronts with a 2-in. drop branch at each, entering one of the drums through two gate valves with a check valve between them. The pump takes its suction from a 2½-in. line through which water may be delivered directly from the condensation tanks or from the city mains for make-up, passing either directly to the pump or through the cooling coil in the blow-off tank; the latter at present serves for the heating of the boiler feed. The injectors are all connected for operation independently of the main feed header, one being attached individually to each of the boilers, with direct water supply from the city service and delivering to the branch connection from the feed header at the check valve.

Coal is stored in a vault 200 ft. in length by 20 ft. in width beneath the Bridge St. sidewalk which has a capacity for approximately 600 tons. Delivery to the fire room is accomplished by charging cars and a 24-in. industrial railway extended into the bunker space to permit of loading directly into the cars. The tracks are formed in the cast-iron floor-plate construction, slots in which provide for the wheel flanges. The system extends in front of all the boilers and beyond at one side to an elevator for hoisting ashes to the court space above for removal. There are five steel charging cars, each having a capacity of about 500 lb., and a platform scale in the track leading from the vault to the boiler room permits weighing the coal as it is used. There is also an interesting arrangement of dumping hopper cars and weighing apparatus in the upper part of the coal vault for weighing the coal as it is dumped into the vault from the street. There is an elevated runway in the vault so that the cars are close to the sidewalk above, and may be brought beneath any of the coal holes. When coal is received, it is dumped from wagons down directly into one of the two hopper cars on this track, and when a car is filled it is moved to a weighing scale in the track near the center of the vault and afterward may be moved to any part of the vault and dumped. The two cars can therefore receive coal through any of the sidewalk coal holes with great rapidity, weighing it before dumping into the vault. Each car will hold two tons of coal and has ball bearing wheels for ease of operation.



Automatic Dampers in Window Sash.

The heating and ventilating equipment of the Custom House was designed by Mr. B. S. Harrison, consulting engineer, of New York. The architect of the building was Mr. Cass Gilbert, New York. The steam plant and ventilating equipment were installed by the New York Steam Fitting Company, New York, the duct work and air washing equipment having been installed by Herrmann & Grace, Brooklyn, N. Y. The coal handling equipment, including weighing apparatus and cast plate floor construction, was furnished by the New Jersey Foundry & Machine Co., New York.

An Interesting Installation of Variable Speed Motors.

A variety of methods of driving machine tools have been investigated in the new projectile shop of the Firth-Sterling Steel Co., at Demmler, Pa. In the line of mechanical drives, five-step cone pulleys were reduced to two steps and a much wider belt was used to drive the machines, owing to the increased power requirements. This method did not give satisfaction in practice and was soon abandoned. The multi-voltage system of motor drive was next investigated but did not meet with favor, and the Westinghouse auxiliary field motors were then adopted and have given entire satisfaction.

The equipment consists of eight 10-h.-p. motors, driving eight 26-in. Bullard lathes, two 15-h.-p. motors, each driving a Bullard horizontal boring machine; and one 7½-h.-p. motor direct connected to a Bullard turret lathe. The speed of the motors is varied by controllers with twenty-one notches, giving twenty-one motor speeds. There is also a 35-h.-p. constant-speed motor belted to a line shaft which furnishes power to a group of small machines including a planer, cutting-off machine, centering machine and two drill presses.

A novel method of checking the efficiency of employes is made possible by the use of electrically driven machinery. It consists of placing, in a convenient location for observation, a recording ammeter arranged to be connected in circuit with any machine whenever desired. Previous tests have determined approximately the current required for a given class of work, so that the record of the ammeter indicates whether or not the machine is working up to its capacity and the time it stands idle.

The opportunity of comparing the relative outputs of similar machines performing the same class of work in the same manufacturing plant rarely presents itself in as forcible a manner as in the Firth-Sterling plant. The old projectile shop still uses belt-driven lathes, some with wide belts. These belt-driven lathes are the same type of machines as the motor-driven lathes, and the result of some very interesting tests of the number of projectiles finished in ten hours show conclusively the greatly increased efficiency of motor-driven machines.

TABLE SHOWING OUTPUT OF BELT AND MOTOR DRIVEN LATHES.

Diameter of projectile	6 in.	7 in.	8 in.
Projectiles finished in 10 hours, motor driven lathe	38	32	25
Projectiles finished in 10 hours, belt-driven lathe	27	27	17
Per cent increase	40.7	52.3	47

Average increase in output, 46.6 per cent.

The belt-driven lathes will eventually be changed to motor drive, which is accomplished by adding an inexpensive mounting for the motor. The shop with the motor-driven machines presents a clean and light appearance.

Conditions on the Isthmus of Panama.

Extracts from a report to the Secretary of War by Chairman Shonts of the Isthmian Canal Commission.

Water Supply.—Chief Engineer Stevens reported that the present dry season had extended over a longer period than any other during the past twenty-five years. As a result streams available for water supply were lower and the fear of a possible water famine greater than for many years. While the reservoirs supplying the districts of Panama, Empire, Gorgona and Bas Obispo contained sufficient water for many months to come, the water in the reservoir supplying the district of Colon had become reduced to 1,500,000 or 2,000,000 gal. Therefore, as a means of impressing upon persons residing in that district the danger of extravagant use of water, Mr. Stevens equipped a water train, erected three temporary water stations in the Colon district, and began hauling into that district 250,000 gal. per day for daily consumption, holding the supply in the reservoir for a possible emergency. This means of adequately meeting the daily needs will be continued until the rainy season again provides an exhaustless supply through the use of the reservoir system.

In this connection it may be stated that a short time ago the water supply of the district of Colon, which had been owned and operated by the Panama Railroad as a commercial proposition, was transferred to the jurisdiction of the Canal Commission, and the Commission, following the policy adopted upon the completion of the water works system of the district of Panama, ordered that water be furnished free to persons living in the district of Colon. The emergency measures above outlined, to provide sufficient water, resulted in no change in this policy, and the inhabitants continue to be furnished water free of cost.

Health Conditions.—Under the direction of Governor Magoon health conditions on the Isthmus are most satisfactory. Notwithstanding the fact that there are more employes and their dependents on the Isthmus than ever before (the monthly pay rolls showing from 22,000 to 23,000 employes with a daily effective force of about 16,000 or 17,000) there were fewer patients in hospital than for many months past. Dr. Gorgas reported 450 beds vacant in hospitals. There has been no authentic case of yellow fever since last November. Mosquitoes are so scarce that many persons sleep in unscreened houses, and discard mosquito netting without incurring personal discomfort. Dr. Gorgas is sanguine that he has the health situation so well in hand that no epidemic can arise within the Canal Zone. The danger can come only from the outside. The question of quarantine is, therefore, of paramount importance, and is receiving the earnest attention of the health department.

Food and Quarters.—Under the direction of Chief Engineer Stevens, through the building department, the policy adopted to provide for the employes suitable quarters in which to live has been carried forward with great vigor. The building department has not only provided ample quarters for the existing force, but at this time has a reserve sufficient to accommodate 3,000 additional laborers. It has also provided suitable quarters for all American employes who may now be living in Commission houses, except in isolated cases where economic and other conditions may make a change undesirable.

Under the direction of Chief Engineer Stevens, through the labor and quarters department, and the commissary of the Panama Railroad, the policy adopted to provide suitable food at reasonable prices, while not yet satisfactorily effected, has nevertheless made great progress. So far as the common laborers are concerned, uncooked food is obtainable at reasonable prices from the commissaries of the Panama Railroad. Mess kitchens have been created at the different labor camps, where wholesome and nourishing meals may be obtained by such laborers at a cost of 10 cents each, and at this price a small marginal balance in favor of the Commission is left. It is a deplorable fact, and one difficult to account for from the American point of view, that these laborers do not avail themselves of this privilege except in small numbers. This is not due, it is believed, so much to penuriousness as to a desire to indulge in eatables less suited to their physical needs, and to gratify other desires. To meet this condition, because of its direct and immediate effect upon the efficiency of the labor, the executive committee has authorized the chief engineer to insert in all future labor contracts a proviso whereby the employe agrees to permit a fixed amount to be deducted from his daily wage, in consideration of which he is to receive three wholesome and nourishing meals a day. The establishment of this method of overcoming the harmful attitude of the common laborer toward his physical needs must be gradual, and it has, therefore, been left to the chief engineer to fix the times and places when it shall become operative among the various consignments of labor and labor camps.

With respect to the American employes, progress continues to be made in providing them with wholesome food of a character to which they are accustomed. Refrigerator cars of the most approved type are now in operation on the line of the Panama Railroad; a temporary cold storage plant is in successful operation at Colon, and plans for a permanent plant on a much larger scale are well under way. Refrigerating plants have been installed on two of the steamers of the company, operating between New York and Colon, and a plant will be installed on a third within the immediate future. A line of refrigeration has, therefore, been established between all points in the United States and the various districts within the Canal Zone, thus placing within the reach of all classes of employes perishable and other food supplies of the character to be found in the United States. The first consignments of American meats have been successfully distributed along this line of refrigeration. The first consignments of vegetables, and similar food stuffs, did not meet with equal success, possibly due to the state of the vegetable market at home when such consignment was made.

Nine large mess houses are maintained at as many different points along the line, where nourishing meals are served in clean surroundings, at a cost to employes of 30 cents each. In the inauguration of the policy of furnishing meals to the American employes at this price, a loss was sustained by the Commission, it being a well-known fact that all work in its formative period, with inexperienced help in many instances, must be carried on at greater cost than prevails after an organization has become more efficient. Figures for the latest month available, however, show that these meals are now being furnished to the American employes at 30 cents each, without additional charge against the funds of the Commission.

In addition to the maintenance of these mess houses the American employes are permitted to buy uncooked food supplies from the commissaries of the Panama Railroad, and may also secure meats and other perishable foods through the medium of the line of refrigeration above mentioned. The charge to employes for such supplies is that paid by the Commission, plus a fixed percentage to cover the expense of transportation and distribution.

Additional mess houses are well under way, and a continued improvement in this service will be brought about during the next few months. In this connection particular mention should be made of the Tivoli Hotel, situated on Ancon Hill, containing 160 sleeping apartments, many of them with private baths. The structure is completed and the hotel will be ready for occupancy as soon as the interior fittings and furnishings can be installed.

Culebra Cut.—The work of putting Culebra cut in shape for the approaching wet season, as well as for the installation of the largest possible number of steam shovels on a systematic plan, has been steadily carried forward. All the barriers across the cut left by the French have been removed, and not only have tracks been laid and ballasted on each level, but for most of the way through the bottom of the canal prism a well-ballasted double-track line has been constructed. About 60,000 yd. of the dirt slide have been removed, leaving a berm 150 ft. wide back from the slope of the canal prism, so that if this slide continues to come down none of it will push over into the prism, as it has done heretofore. Following this same rule, in two or three years more the entire slide will have been removed. Clay on the top of the cut, on the other side of the prism, which can not well be handled during the wet season, has also been removed wherever there was danger of the side of the cut going far enough back to permit this clay to slide into the prism this season. This work is so well along that if the present good weather should continue two or three weeks more Culebra cut will be in such shape as to permit of the removal of the largest quantity of material during the wet season, without danger from any of the mishaps from slides or derailments due to bad tracks which have heretofore been attendant upon such efforts.

Chief Engineer Stevens during the month of March, without making any special effort, but following the general policy of work herein outlined, removed 240,000 cu. yd. of material, with an average of 10.7 steam shovels working. The reports up to April 15 indicate a still greater degree of efficiency in excavation. He believes that by July or August he will have forty shovels installed, and will be in a position to remove approximately 1,000,000 cu. yd. per month. The actual cost for material handled during March, figuring in contractor's expenses, was 53½ cents a cubic yard.

Materials and Supplies.—Under the direction of Mr. W. G. Tubby, head of the division of material and supplies, appointed some five or six months ago, order and system prevail in this important work. Materials and supplies on hand have been inventoried, new storehouses constructed, lumber yards provided, and a system established whereby Mr. Tubby knows every day exactly what materials and supplies he has on the Isthmus, and where they are located. The danger of duplication of orders has been removed, and although materials and supplies have been received in larger quantities than ever before they have been handled with expedition and at greatly reduced cost. Under Mr. Tubby's administration bills for materials and supplies received are checked and returned to the United States for voucher and payment by the next steamer after their arrival. The improvement in this department during the past few months has been phenomenal.

Working Force.—The working force of the Isthmian Canal Commission as of date April 1, was distributed broadly among the different departments, as follows: Government and sanitation, 2,845; materials and supplies, 1,670; auditing and disbursing, 90; engineering administration (including care of quarters), 460; municipal engineering (in charge of construction of water supply, sewerage, roads, etc.), 3,295; master builder (in charge of houses and quarters), 2,946; motive power, shops, etc., 1,521; Culebra division, canal, 3,103; La Boca division, canal, 384; Cristobal division, canal, 433; Chagres division, canal, 134.

The morale of the force and its efficiency continue to improve. As the employes in all the departments get more familiar with the work required of them, and as the organization becomes more settled, a corresponding increase in the effectiveness of the force follows, as is shown by increased work at a less cost than before. This is even true, to a more or less extent, of the common laborers from the West Indian Islands. As the American foremen become more accustomed to their ways and understand better how to handle them, and as the common laborers become more familiar with the work that is expected of them, they are taking more interest in the work and becoming somewhat more efficient. However, it is not expected that any high degree of labor efficiency will be developed until a better class of labor is introduced.

Law and order continue to be maintained to a degree that would be remarkable under any conditions, and is especially so when the character of the population of the Zone is considered, with its vast army of 23,000 employes gathered from all parts of the world. Under the administration of Governor Magoon the police force is so vigilant and so efficient that good order is steadily maintained, serious crime is almost unknown, and arrests are mainly for petty offenses and violations of the sanitary laws.

Recreation for Employes.—During a former visit to the Isthmus the Commission was accompanied by two special employes, recommended to it by civic organizations in this country, for the purpose of systematically approaching the important question of providing proper diversion and social recreation for the American employes on the Isthmus. Conditions at that time, however, were such that every energy had to be directed toward the more necessary and vital work of providing proper housing and feeding facilities for the employes, and the work of providing diversion and social recreation was at that time passed over. It was, therefore, very gratifying to see on this trip that the American employes had taken up this question themselves and organized clubs at various labor centers. It was my pleasure to attend an entertainment given by a club composed of representatives of the various kinds of skilled labor, and of office men, located at Corozal. The entertainment was well attended, and of a high class throughout, and if it is indicative of what is being done by other clubs on the Isthmus this important question of social recreation and diversion will solve itself. The men, with true American spirit, evidently appreciate that those things which are the outgrowth of our own desires and achieved by our own efforts are, in the long run, more lasting and more satisfactory. The Corozal Club was, however, assured, and through it the other clubs along the line, that the Commission had not lost interest in the matter, and would gladly cooperate in providing club houses and such furnishings as would be proper and right for it to provide.

Removal of Headquarters.—Following the policy decided on at the time of a former visit to the Isthmus, Chief Engineer Stevens has removed his headquarters from Panama to Culebra. The residence of the chief engineer and the administration office buildings have been occupied for several weeks. Some of the necessary quarters for the officers and headquarters employes are finished and occupied, and additional quarters to amply provide for the remainder will be ready for occupancy in a very short while. Meantime, some of the employes are brought from other nearby quarters on the line of the railroad. The chief engineer reports that he is delighted with the new location, and that he thinks the efficiency of the force has been increased fully 50 per cent.

Acting under the same general orders, issued in August last, the disbursing and auditing departments will be moved to Empire, a short distance from Culebra. The necessary buildings are under way, and it is hoped that the force will be moved within sixty days.

Work is in progress on the foundations for the governor's house on Ancon Hill, but the administration building for the governor, to be also situated on that hill, has not yet been commenced. Meantime the offices of the governor are continued in the old canal administration building in the city of Panama, which affords them ample office space.

Conclusions.—The results already obtained justify the policy decided upon during my first trip to the Isthmus, and briefly outlined in my report to the President under date of Aug. 12, 1905. In that report I called attention to the fact that the serious mistake which had been made up to that time was in attempting "to make the dirt fly" in advance of thorough preparation, and informed the President that instructions had been issued to close down the work of excavation, except in so far as it was necessary to put the cuts in shape for the installation of the maximum number of steam shovels for economical service.

The work of canal construction divides itself properly into two parts, one of which must precede the other.

First, thorough preparation. This includes the creation of an effective organization; the sanitation of the Isthmus; providing suitable quarters and food for employees; constructing proper terminal, yard, and railway track facilities and intermediate yards for the handling of the vast quantities of supplies and materials; the installation of a system of tracks through the cuts; the working out of all engineering problems, and the formulation of a comprehensive plan for carrying forward the work in each department.

Second, the actual construction of a given type of canal.

The work of preparation is at once the more important and the more difficult of these two tasks. If it be not done thoroughly, intelligently, and well in every part, the second task—that of actual construction—will be handicapped from the start. The launching of every great enterprise, the creating of an organization with which to carry on the work, is always the most difficult part of it. Once that has been accomplished successfully, the subsequent task of execution is comparatively easy. This preliminary stage is nearing completion on the Isthmus. Inspection during this last visit showed that the many intricate problems connected with the engineering branch of this task have been worked out, that in many other departments the preliminary work has been completed, and each week is witnessing its completion in others. Other necessary work will occupy the organization to advantage for a short time to come, but at the present rate of progress the time is fast approaching when decision as to type of canal will be essential to the continuation of work.

Type of Canal.—Finally, the most important and pressing question before the Commission today is a decision in regard to the type of canal to be constructed. Chief Engineer Stevens pointed out to me the route of several diversion channels the construction of which should be underway but which he can not commence until the type of canal is decided upon. We have also in mind certain other intermediate yards which we can not locate until that decision is reached. We are also holding back the improvements at La Boca (the Pacific terminus), both as to terminal yards and the extension of the steel pier, already referred to, not knowing whether or not the type decided on will cause us to abandon all these improvements. The extent and character of additional machinery to be used, as well as the extent and character of additional equipment to be purchased, are all awaiting the determination of this most vital question, and inasmuch as all this machinery and equipment must be manufactured to order in the United States, and manufacturers in almost every branch are filling their books with orders months ahead, the delay in reaching a decision as to type may mean a very serious delay in getting the necessary plant, and thus ultimately mean serious delay in the construction of the canal.

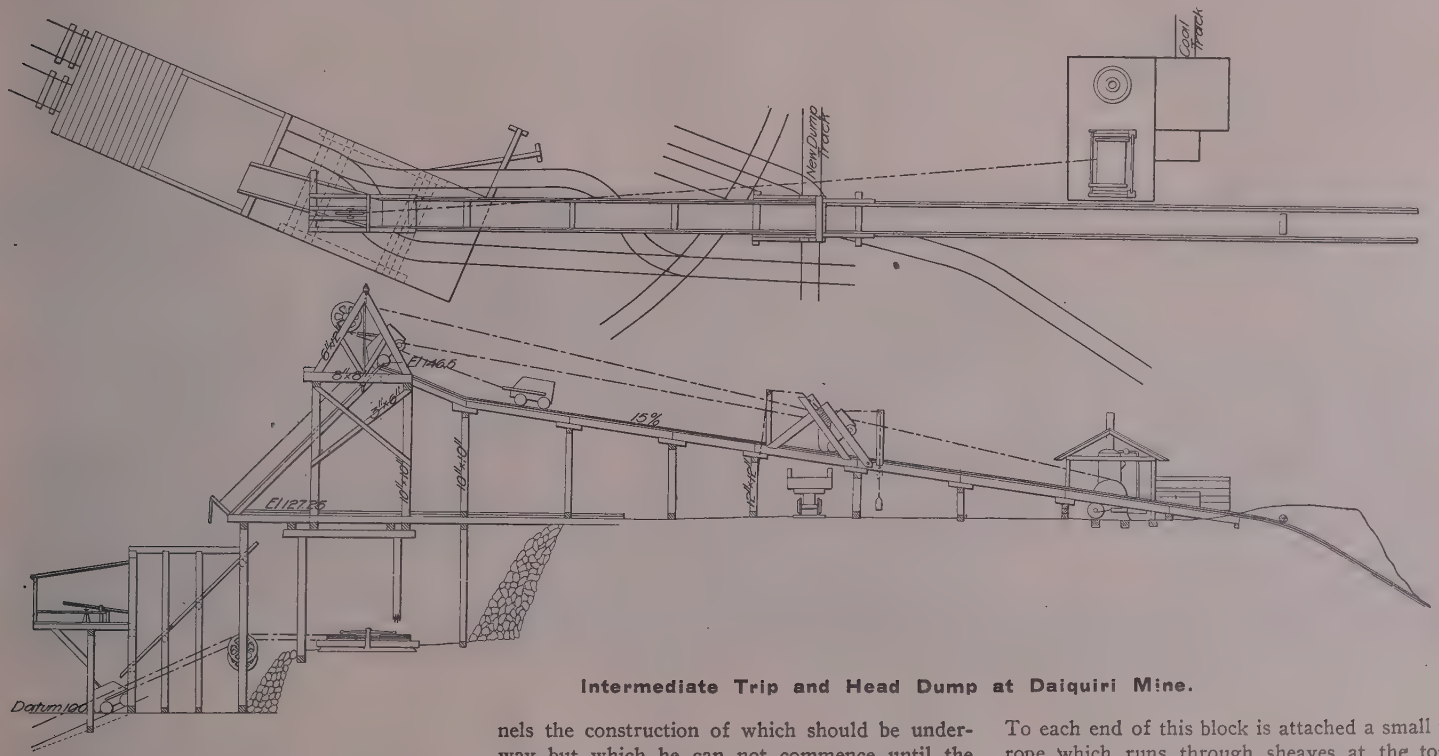
The Singapore Harbor Improvements, giving a depth of 24 ft. at the quays, will be executed by Sir John Jackson, Ltd., whose tender was $5,426,000.

An Intermediate Skip-Car Trip on a Power Plane.

By E. M. Holmes, M. Am. Inst. M. E.

The plane illustrated in the accompanying engravings is used at the iron mines of the Spanish-American Iron Co., a subsidiary company of the Pennsylvania Steel Co., at Daiquiri, Cuba. Mining out the ore along the contact led a part of the workings below the main level and the top of the gravity inclines. To deliver the ore a power plane was installed with the skip-car dumping directly into the top pocket of the gravity incline. One cut shows the top of the power plane and the gravity incline to which the ore is delivered.

As both ore and waste have to be raised, some arrangement was necessary for tripping the car when loaded with waste, before reaching the top. The accompanying diagram shows the device. Part way up the incline stringers were thrown across one span, on the outside of the track stringers, and spaced to allow pivoted stringers to be placed between them and the track stringers. On these outside stringers a triangular rigid framework is erected, which carries a sliding block. To each end of this block is attached a small wire rope which runs through sheaves at the top of the frame and thence under the track, where the two ends are brought together at the end of a lever, worked by a man standing on the ground. By this means the block is raised to allow the pivoted stringers to swing past it or lowered to act as a support when the car is to be tripped.



Intermediate Trip and Head Dump at Daiquiri Mine.

The pivoted stringers are fixed at the lower end by a rod running through the whole structure (iron shoes are placed on the bottom to prevent splitting), and are fastened together by a rod which extends up and over the track so as to allow the car to pass under it when the stringers are down.

Just in front is an upright frame carrying sheaves, through which ropes lead from the pivoted stringers, thence passing down and under track, where counterweights are attached.

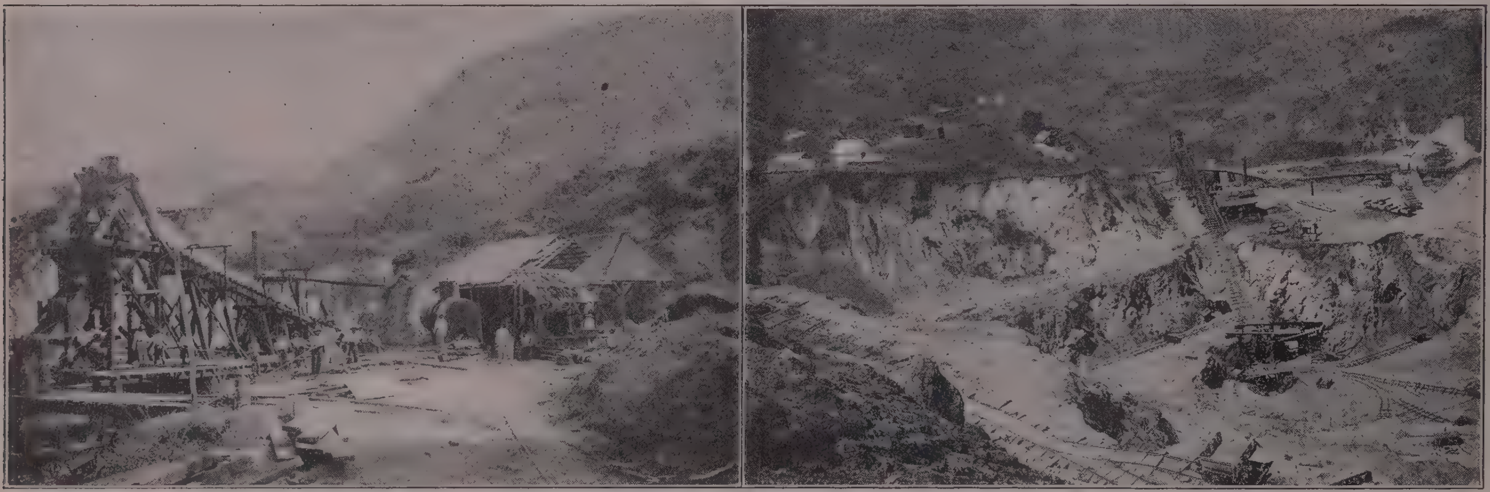
The operation of this trip is as follows: When the stringers are down the car, which has a tread on rear wheels, passes through it and on to the top of the plane. When it is desired to dump waste a car is run under the trip on the dump track, the counterweights are pushed down, thus raising the pivoted stringers, and the lever which is holding the sliding block is released so as to permit the block to slide down and act as a support for the ends of the pivoted stringers. When the car reaches this point the treads on the rear wheels ride these pivoted stringers, now held in an inclined position.

To prevent the front wheels running back down the track and overturning the car a cross piece is inserted from one track stringer to the other, against which the front end of the car body rests when the back wheels are elevated.

This appliance has been in successful operation for some time and its wide applicability recommends it, as well as its low cost, for it can be constructed from materials and by laborers at hand on any work.

The Drop Manhole Patent.

The Drop Manhole Patent has again been hauled above the horizon of some cities in the Central States to scare the local authorities. There is nothing about this bogey that deserves the slightest consideration, even to the extent of a two-cent stamp to acknowledge the receipt of the patentee's letter threatening suit for infringement. This journal investigated the subject fourteen years ago, and discovered the fact that the man who took out the patent previously worked on the construction of a sewerage system at Springfield, Mo., designed by Capt. R. F. Hartford. The latter's plans called for drop manholes and the only change in these designs which was made in the patent subsequently issued was the alteration of the drop from an inclined to a vertical position, an unimportant matter in view of the fact that manholes with vertical drops were previously employed elsewhere.



Two Views of the Power Plane at the Daiquiri Mine of the Spanish-American Iron Co.

The Marysville Public Library, designed in the office of Mr. William Curlett, a San Francisco architect, had its interior structure of columns, girders, beams and floor slabs built entirely of reinforced concrete, the Kahn method of reinforcement being employed. The main girders are 18 x 32 in. in section with a span of 32 ft., and the floor slabs have spans of 18 to 20 ft., being made of hollow tile separated by concrete beams 16 in. on centers. The concrete work in the building was particularly satisfactory to the architect. The walls are of brick with stone facing. This structure passed through the recent earthquakes without injury, but Mr. Curlett believes that had it been in San Francisco, where the shock was much heavier than in Marysville, the brick walls would not have stood as they did. He considers that the earthquake has proved it to be bad practice to combine these two methods of construction, all concrete work being preferable.

The Management of Suction Gas Producers.

A voluminous paper on the development of suction producers was read last month before the Junior Institution of Engineers by Mr. William A. Tookey. In its course he furnished many suggestions concerning the operation of this type of producer, some of which are here republished from the abstract of them given in the "Journal of Gas Lighting." The first point relates to the diameter of the fire of generators, which should vary, the author stated, with the area and speed of the engine piston, and to some extent with the quality and size of the fuel. The successful working of a suction or pressure plant when supplying gas for an engine working under light loads is dependent upon the fire being maintained at a proper temperature to effect the chemical changes, without which producer gas cannot be generated. It is, therefore, necessary to restrict the grate area as much as possible, so that the diminution of pressure throughout the apparatus, consequent upon the withdrawal of gas by the engine, shall induce air to enter at such velocity that the fire is quickened and the utmost incandescence obtained throughout the whole bed of fuel even under light loads. There are practical details, however, which decide the minimum diameters allowable. The size of fuel must be considered. Care must be exercised to retain a diameter that will not hinder the fuel in settling down during combustion. Sufficient "blowing" area must be provided for the entry of air in relation to the "dead" area occupied by the fire bars or hearth. Allowance must be made for the accumulation of ashes which clog up the apertures, and restrict the proper draught. It must be remembered that small areas increase the velocity of entering air, and entail high temperatures, which encourage the fusion of fuel into clinker under the heavier loads. Fires small in area demand increased depth of fuel for the proper manufacture of producer gas, and deep fires entail greater variations in internal pressures before the air can be induced to pass through the generator, reacting upon the power developed by the engine. Fires too large in area reduce the initial velocity of the air passing from below the grate, produce slower combustion than with forced draught, and allow the incandescence of the fuel to diminish under light loads. If carried to extremes, the heat becomes insufficient to gasify the carbon, and the production of producer gas ceases. Experience has shown that the diameter of the fire at its base—or combustion zone—is best expressed as a function of the piston area and displacement. The British practice seems to be that a 50-brake h.-p. gas engine, having a piston of about 15 in. diameter, a displacement of 2.25 cu. ft., and a mean piston speed of about 600 ft. per minute, shall draw from a producer of about 15 in. diameter fuel base.

It has already been pointed out that it is essential for good results that there shall be a sufficient depth of incandescent carbon exposed, in order that dissociation of steam and production of carbon monoxide can be properly and completely effected; but it is unnecessary to provide a huge bulk of fuel, which merely entails resistance to the progress of the ascending gases. A common depth of incandescent fuel is 20 to 24 in.; while in the smaller producers 15 to 18 in. is allowed when anthracite beans or small nuts are used. As a matter of fact, suction producers, after being once charged and thoroughly heated up, will continue to give gas, even when the fire has been allowed to sink to less than 10 or 12 in. thickness, while, in many cases, with engines lightly loaded, a still less depth—about 6 to 8 in.—has been found to yield sufficient gas. In the latter cases, however, it is only when no further fresh fuel is added that such results are possible, as the feeding of a cold charge on a low fire would spoil the gas making temperature.

In order to maintain good gas, Mr. Tookey stated, it is imperative that the depth of fire should not vary. It is, for this reason, a common practice to arrange a storage bell of ample capacity, within the generator and above the fire, so that a pile of warmed coal always rests upon the incandescent fuel. This black mass of fresh fuel gives off its volatile constituents during the gradual sinking of the charges into the incandescent zone, and becomes coked before it reaches the gas yielding portion of the generator. By means of feeding hoppers, new charges are made from time to time, so that the bell is always filled for several inches above its bottom rim. In the absence of such distilling "bells," the coal falls directly upon incandescent carbon, reducing its temperature, and causing all the volatile constituents of the uncoked fuel to mix with the good gas. The absence of it also permits the tarry vapors to escape from the generator before they can be converted into fixed gases—thus affecting the running of the engine, as well as causing the dirt and dust to be drawn along the connections and to gradually choke up the pipes and the coke in the scrubber.

After leaving the fuel bed, the gases—before being conducted away from the generator and passed to the cooling and washing processes—are allowed to collect in the upper portion of the generator, and to circulate round the distilling bell. In many designs they are made to pass under or through a dish of water before the final exit. Sometimes the outlet is placed at a considerable distance above the fuel bed, to allow a large quantity of coal to be distilled gradually within the generator. As the products yielded during the process expand downwards through the coal, the great heat of the rising gases converts the tarry vapors into fixed gases; and in this way, with efficient washing in the scrubbers, the tar difficulty is reduced to a minimum. Messrs. Pintsch, instead of allowing the gas to circulate round the distilling chamber, provide an annular collecting space about half-way up the generator. This method has much to commend it. The "Dynamic" gas producer is fitted with a gauze screen around and above the fuel. The screen filters the gas, and holds the solid particles within the generator until converted. This device also protects the plant from risks of explosion through any accidental combustible mixture in the exterior apparatus being fired by the fuel in the generator. When comparing the designs which have as a feature a large cast-iron "distilling" bell above the fire, it is to be observed that, to avoid the drawing up of incandescence through one portion only of the fuel, and especially when light loads only are being served, many manufacturers build the fire brick lining so that the gas is diverted from a straight path from the fire to the gas outlet.

The Top of the Power Plane and Gravity Incline, Daiquiri.

It is considered by many makers somewhat unnecessary to adopt mechanical stoking for the usual sizes of suction plants, which, as a rule, require recharging only with small quantities at intervals of two hours or so. As a matter of fact, the coal consumption, while somewhat proportionate to the load factor, is not entirely so; and therefore, for the maintenance of a uniform depth of fuel, it is always necessary to make some adjustments by hand to any automatic device according to the load. Otherwise, if set for normal working conditions, the fire gradually sinks under light loads when proportionately more fuel is burned, or, if set for light work, any continued increase of load upon the engines increases the height of fuel, owing to the greater number of explosions taken by the engine, although the gas at such times is richer in hydrogen, and the required volume is generated from proportionately less coal. The necessity for this adjustment would not occur when fairly steady loads are carried.

Owing to the varying grades of fuel used in gas producers, means are usually provided for raking out ashes and clinker that may be formed at the base of the fire, and thus ensuring continuity of operation for extended periods. Without these facilities, it is rarely possible to obtain a sufficiency of good gas for longer than ten to twelve hours; while plants permitting poking and clinkering during operation have run, upon occasion, for 700 hours. A door below the fire-bar level enables the accumulation of ashes to be pricked from the spaces between the bars, while two or more doors round the generator, above the bars, permit of the removal of clinker or masses of incombustible slag. In producers having but one poking door, it is very difficult to dislodge the clinker adhering to the generator walls at the back of the fire, and the interior surfaces are usually quickly defaced by the attendant when giving the weekly "clear out." In addition to these doors at the base of the generator, the provision of a poking hole above the fire is of great service in consolidating the fuel bed, and breaking down any "arching" caused by overheating or by inferior fuels.

The designers of separate vaporizing devices point out that, in abstracting heat from the gas between the generator and the scrubber, they are studying the proper action of the apparatus by retaining as much heat as possible within the generator itself, and by reducing the heat as much as possible before the gas enters the scrubber. Thus a saving in both coal and water results. External vaporizers also obviate the tendency to affect the engine's operation after each charge of fresh fuel, as is sometimes very noticeable with vaporizers that are placed round the distilling chamber. Another consideration is that such external boilers are the more sensitive, and respond more readily, to variation of load. Thus as the engine's load increases, and more gas is generated, more steam is made, and vice versa. Usually, also, they are more easily cleaned from deposit, but many types made with heat collection ribs get very quickly sooted up. Suction gas producers having water vaporizers above the lining of the generator are, however, very much used, and, although less sensitive, they are very effective, providing a copious amount of steam and requiring little or no attention or adjustment. The steam if excessive escapes to the atmosphere, and it is only sucked below the fire when the engine takes gas.

Different designers place the vaporizer round the generators in other positions—round the base of the fire, or round the generator towards the top of the fire. It is claimed that, where the vaporizers are in such positions, there is a great reduction in the amount of clinker formed, and what there is cannot adhere to the cast-iron water vessel, is very soft, and is easily broken up. This is certainly a great advantage; and the linings of generators so fitted last a much longer time, because of the gentler treatment by the attendant with the clinkering iron. A great number of the generator linings inspected by the author have been seriously damaged by the defacement of the internal surfaces due to the adherence of clinker, and the zealous efforts of the man with the poking tool to dislodge it. But in such producers it will be recognized that the fire is worked at less heat; and thus any serious diminution in load on the engine is the more quickly felt.

It has been mentioned that vaporizers included in the generator design are less sensitive than those heated only by the hot gases in a vessel entirely separate. With light loads, this is somewhat of a defect, as the amount of steam drawn down with the air to the fire after heavy loads does not appreciably diminish for some considerable time. Consequently, the gas remains of good quality; and the engine takes less explosions in a given period—causing a gradual reduction in the temperature of the fire and irregular running.

A constant supply of water to the vaporizing devices, at a regular pressure, is very desirable; but usually little care is taken to ensure this. An unreliable water service is a source of anxiety to the attendant, as, when working on a fairly uniform load, too much water decreases the amount of steam generated, while a diminished supply increases vaporization—with the risk of overheating, fracture and burning of parts should the quantity be insufficient to replace the quantity evaporated. In many instances the author has traced irregularities in working of plants to variations in the water pressure when a branch from a service pipe to other processes has been utilized; and the use of a small feed tank and ball valve, from which the vaporizer and sprinkler can be fed at a constant head, is preferable.

Bulk vaporizers yielding a large amount of steam are not very sensitive to fluctuating demands from a gas engine. If no regulation of the amount of steam admitted to the fire be attempted, the amount of steam available under light loads is often excessive, as evaporation is still going on under the influence of the heat previously generated; so that, although during "cut out" cycles the excess escapes to atmosphere, yet whenever the engine sucks a charge, the steam is drawn in through the fuel, yielding a comparatively rich gas. Explosions of rich gas naturally occur less frequently than when poorer gas only is available; and the result is that, should the lighter loads last more than a few minutes, the absence of a current of air through the fire allows the temperature to be reduced, probably to such an extent that the effective degree necessary to dissociate the air and steam is not maintained. Gas making thereupon ceases, and the engine stops. It is desirable, therefore, when engines subject to extreme fluctuations of load are served, that some means should be provided whereby the steam can be reduced or increased according to the load.

The majority of British makers place the fan used in starting up in such a place that a blast of air is forced through the fire; and it follows that the gases evolved are above atmospheric pressure when the fan is in use. Already some accidents have arisen in consequence. Quite recently an attendant at Seaford was asphyxiated by inhaling gas escaping from a plug in the expansion box, which he had, presumably, removed to allow water to drain away. Such accidents are due to the carelessness of the attendants themselves in not recognizing the danger of allowing large quantities of gas to escape in the engine room when starting up with a pressure fan; but there is little doubt that such fatalities will cause makers to avoid the risk by adopting exhausting fans.

The Board of Water Supply of New York City received last week from the State Water Commission full approval of its plans.

The Rigidity of Constructive Materials.

By James E. Howard, Watertown, Mass.

The relative rigidity of the materials of construction, as shown by their moduli of elasticity, is exhibited on the accompanying diagram and the table of numerical values. The data used in their preparation are from the results of tests made at the Watertown Arsenal, although some of the data might, of course, be had from many other sources.

These ratios of stress to strain are based upon the effect of loads within the elastic limits of the materials. For those cases in which the elastic limits were not well defined, by reason of the early and progressive development of permanent sets, the resilient movements were used instead of strains under direct loads. Tensile stresses were applied to the steel, wrought iron, cast iron and bronze; compressive stresses to each of the other materials here represented.

The results of a number of tests on each kind of material were examined and representative moduli selected for the present exhibit.

Steel displays the highest modulus of elasticity of any of the materials of construction. It also has a more nearly constant value than any of the others. Its modulus is found to remain in the vicinity of 29,500,000 to 30,000,000 lb., with great persistency, notwithstanding the chemical composition may extend over the limits of ordinary commercial steels.

It follows, that mild steel and hard steels will each extend, compress or deflect substantially the same amounts for the same loads, the elastic limits not being exceeded in any of the grades.

In respect to imparting a higher modulus no method of treatment has been found whereby it may be elevated above its normal value.

Moduli of Elasticity.

Material.	Modulus of elasticity, pounds per square inch.
Steel	29,500,000 to 30,000,000
Wrought iron	26,800,000
Cast iron	14,300,000 to 18,000,000
Bronze	10,000,000 to 14,300,000
Granite	5,000,000 to 9,800,000
Marble	4,000,000 to 15,000,000
Limestone	4,000,000 to 14,700,000
Slate	16,200,000
Bluestone	7,000,000
Sandstone	1,100,000 to 4,000,000
Bricks, hard	10,000,000
Bricks, light hard	4,500,000
Bricks, salmon	500,000
Portland cement	4,000,000
Natural cement	1,100,000
Long leaf pine, butts	2,200,000
Long leaf pine, tops	1,600,000
Short leaf pine	1,500,000
Douglas fir	1,800,000
Spruce	1,500,000
White oak	1,500,000

It is conjectured that a higher modulus might be realized, for the time being, by exposing the metal to very low temperatures, since the opposite effect results from raising the steel above the range of atmospheric temperatures. At 1,400° F. the modulus appears to have fallen to about 14,000,000 to 16,000,000 lb., per square inch. The rate of reduction is not thought to be uniform, but increasing as higher temperatures are reached.

The modulus of elasticity may be lowered temporarily by overstraining the metal at ordinary temperatures. From this state there is an early recovery. A return to the normal value has been observed to take place within the limits of a few weeks. The modulus stands as an index of an inherent property of the material, and this characteristic is practically beyond our control.

Wrought iron has a value next to that of steel. Cast iron then follows, for which two values are given, indicating the limits within which the modulus may be expected in different grades of cast iron.

Iron, as such, is the dominant constituent in each of these three cases. The lower and variable value for cast iron is attributed, in part, to its less dense structure compared with puddled iron or steel.

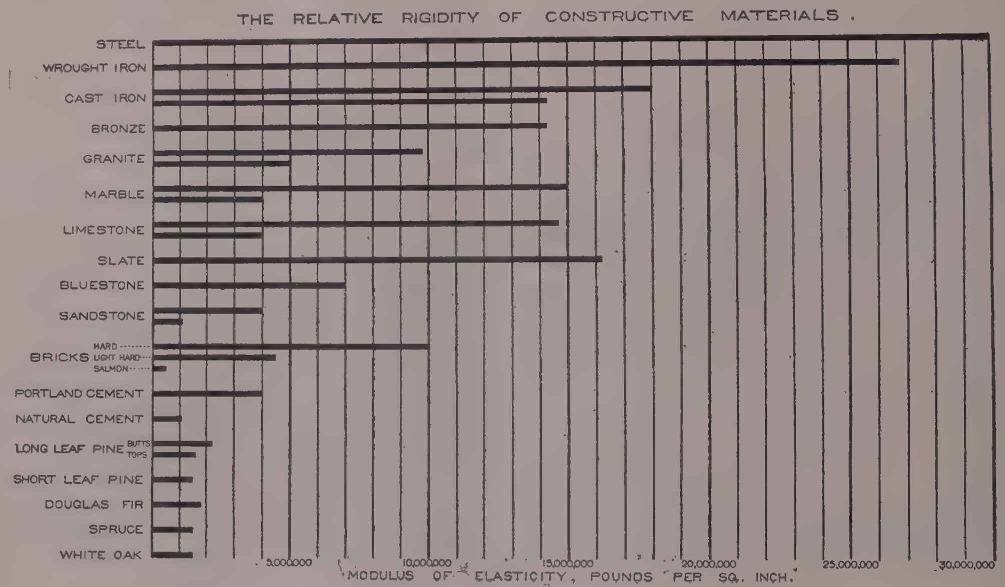
Although little may be done, and that of a temporary character, to modify the rate of extension or compression of steel, yet the total range or amplitude of the strains admit of decided change. When this range is increased it merely means that the metal has had a higher elastic limit imparted to it.

Bronze, as a comprehensive name, includes various compositions the principal constituents of which are copper, tin and zinc, with which iron and manganese are used in some very strong mixtures. The modulus reaches the value shown on the diagram occasionally, but more frequently the range is from 11,000,000 to 13,000,000 lb.

Among the building stones, slates, dolomites and some of the limestones comprise the more rigid examples. Contrary to the general conception of a granite, this rock has not been found to possess so high a modulus as the stones just mentioned. Statuary marble, the weaker limestones and certain granites display the lower values of their respective classes.

Sandstones generally are quite compressible, and some have furnished the lowest moduli among the list of building stones.

Bricks display a wide range in compressibility, salmon bricks representing the most compressible, hard burnt bricks the most rigid. With the increase in the modulus of elasticity there is an accompanying gain both in density and in compressive strength. A marked improvement in the strength of piers could, no doubt be effected, by careful selection of the individual bricks, at the same time giving due consideration to the quality of the mortar in which they are laid.



The Moduli of Elasticity of Different Engineering Materials.

An ordinary value for the modulus of elasticity of Portland cement is 4,000,000 lb. per square inch. Age does not appear to effect a decided modification in this value in individual cases, although age has a pronounced influence on the development of permanent sets.

The highest modulus which has been observed in a Portland was 5,854,000 lb. per square inch. This resulted from subjecting the cement to a very high pressure while setting. Natural cements show moduli much below the Portlands. These two kinds of cement not infrequently have the same specific gravity in the unhydrated condition but after gauging and setting the Portlands have the greater weight per cu. ft. and the greater density. The difference in the shapes of the grains suggests a reason for the lesser density and lower modulus of the natural cements in the cake, notwithstanding their specific gravities are often the same as Portlands.

The moduli of elasticity of cement mortars and concretes depends upon the richness of the mixtures, modified by the conditions of loading. Values in the vicinity of 5,000,000 lb. are occasionally met in rich mixtures, and drop to below 1,000,000 lb. in the case of very lean ones. The application of a higher stress changes the value of the modulus, as it had previously existed taken over a lower range of stress. This is an important feature in reinforced concrete, since the ratio of the modulus of elasticity of the steel reinforcement to the concrete is not a constant one.

No wide variation in the values of the modulus characterizes the several kinds of timber in common use. In long leaf pine the butts show a higher modulus than the tops of the trees. Short leaf pine and the tops of long leaf pine each display about the same value.

Douglas fir is usually slightly more rigid than spruce and some oaks. Spruce and oak frequently have about the same modulus, the more rigid sticks of the latter surpassing those of the former.

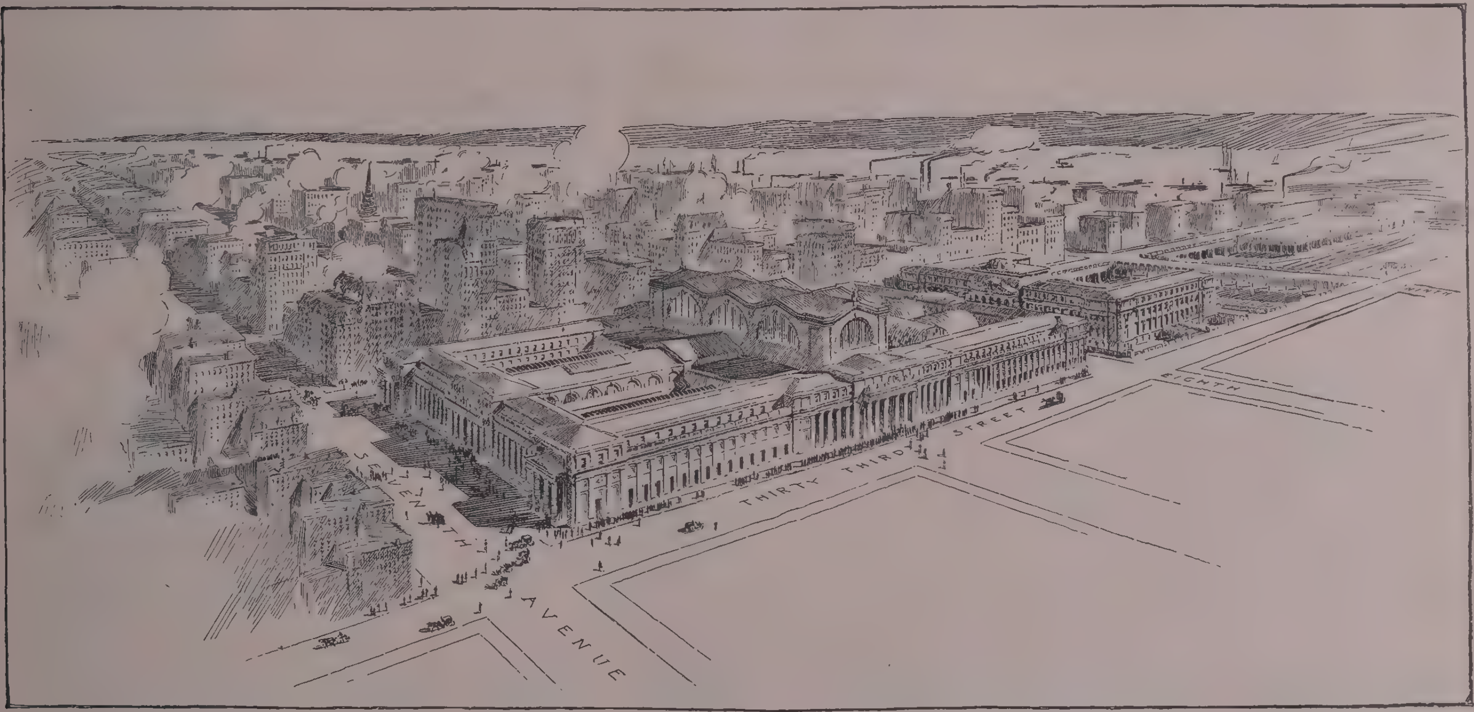
The moduli of wood, above referred to, are for stresses applied lengthwise the grain. Decidedly lower values prevail when loaded perpendicular to the grain, and a difference is also found between loads applied in radial and tangential directions, with respect to the position of the stick in the tree. In one instance the modulus in a radial direction was only one-eighth its value taken in a lengthwise direction. Comparing the radial with the tangential moduli, the latter has been found with but one-half the value of the former.

In tension the modulus of wood is substantially the same as in compression.

The Mechanical Stoking Investigations conducted by the Hamburg Society for Smoke Abatement are reviewed at length in the "Zeitschrift" of the Society of German Engineers for Feb. 3. The tests were made at various rates of evaporation and each lasted 9 hours. With the sprinkling stoker, the sizing and sorting of the coal proved very important, and very rich bituminous grades cannot be burned perfectly without other aid. The underfeed stoker permits bituminous coals to be burned without smoke, but caking coals are troublesome. The chain grade stoker yields good results when the ash of the fuel does not slag, but if clinker forms the type does not use the coal with the best efficiency. It demands much skilled attention and on that account falls behind other types. All frequently gave higher results than hand firing in the tests from which the above deductions were made.

The Passenger Station of the Pennsylvania R. R. in New York.

The new Pennsylvania R. R. station in New York, for which the plans are now practically perfected, will be unique among all the railway stations of the world in the number and convenience of its entrances and exits. This condition is due to the fact that each of the four sides of the structure is a front, opening respectively on two wide avenues and two important streets, which latter have been widened by the company to 80 ft. each. The geography of the station is interesting. It is bounded on the east by Seventh and on the west by Eighth Ave.; on the south by 31st and the north by 33d St., 32d St. having been closed and included in the station site. The advantage of its location in the center of the hotel, theatre and shopping district is obvious. The frontage on the avenues is 430 ft., and on the streets 780 ft., the sides of the structure forming a perfect parallelogram.



Bird's-eye View of the Pennsylvania Railroad Station in New York.

As the tracks are 40 ft. below the surface of the streets, the station is divided into three levels. From the street level upward the walls of the structure rise to the height of 60 ft., except at the center, where the roof of the general waiting room reaches a height of 150 ft., and at the corner of Eighth Ave. and 33d St., where there is an elevation of four stories for office purposes. The architectural design of the entire exterior is a Doric colonnade, 35 ft. high, surmounted by a low attic, raising the general elevation to 60 ft. The unusual extent of the building in area and its general type are suggestive of the great baths of ancient Rome. In fact, the baths of Caracalla, still magnificent in their ruins, were the inspiration of this architectural plan.

Although the building is low by contrast with its skyscraping neighbors, its scope makes it impressive, and the lofty roof of the waiting room, rising high above the top of the surrounding structure, with its eight large semi-circular openings 72 ft. in diameter adds dignity to the group of buildings and at the same time makes them a conspicuous landmark, when seen in perspective from the streets. In appearance it is a wide departure from the conventional railway station. One misses the turrets and towers and more than all the lofty arched trainshed, but as the principal function of this station is performed underneath the streets, the upward and visible signs of the ordinary railway station are naturally absent. It will rather resemble some vast auditorium constructed on low lines for the easy ingress and egress of a multitude of people.

The exterior construction is to be of pink Milford granite, similar to the building stone of the Boston Public Library, the University Club in New York, the Court House in Pittsburg and the Chamber of Commerce in Cincinnati. This is a particularly effective structural stone and its soft shades of color are uncommonly pleasing to the eye.

The main entrance is fixed in the centre of the structure on Seventh Ave., opposite the intercepted end of 32d St. This is for foot passengers only, and from the street entrance to the stairway to the main waiting room there extends an arcade 225 ft. long and 45 ft. wide flanked by shops, which will be occupied by merchants whose wares will appeal especially to the requirements of travelers. On either side of the Seventh Ave. entrance there are also a series of stores. At the further end of the arcade the restaurant, lunch rooms and the café are established, with proper kitchens and service connections. Beyond is the general waiting room and the concourse, all easy of access by convenient stairways.

At the corners of 31st and 33d Sts. and Seventh Ave. are open pavilions, which furnish carriage entrances for incoming and outgoing traffic. Under cover carriages descend from the street level by a slight gradient about 20 ft. to the level of the station proper, the 31st St. incline being assigned as an entrance and the 33d St. ascent as an exit. By this arrangement carriage passengers are delivered at the most convenient entrance to the general waiting room.

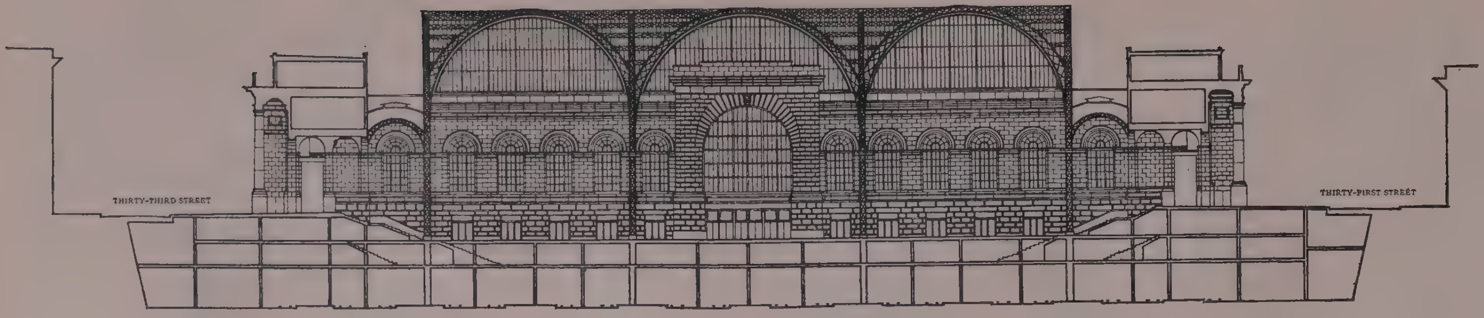
Apart from the main entrance there are other convenient entrances for foot passengers from the street level to the general waiting room and concourse from both the streets and the avenues. At a central point in both streets wide bridges leading into the street floor of the station span the carriage subway.

On the intermediate plane or level the real business of the passenger preparatory to his journey is transacted. The general waiting room, the largest of its kind in the world, 320 ft. long, 110 ft. wide and 150 ft. high, is the central section of the plan. Within its spacious walls will be located the ticket offices, parcel rooms, telegraph and telephone offices and baggage checking windows, all so disposed as to situation that a passenger may proceed from one to the other seriatim, with a minimum amount of exertion and without retracing his steps. Adjoining the general waiting room on the west are two subsidiary waiting rooms, 58 x 100 ft., respectively for men and women, provided with seats and opening into retiring rooms, with lavatories attached.

To the east of the general waiting room the main baggage room, with 450 ft. of frontage for the use of the transfer wagons, is located, covering the full area occupied by the arcade and restaurants on the plane above. The baggage is delivered and taken away through a special subway 30 ft. wide, extending under and along the entire length of 31st St. and Seventh and Eighth Aves. From the baggage room trunks are delivered to the tracks below by motor trucks and elevators. The cabstands will also occupy this level.

Parallel to and connecting with the main waiting room by a wide thoroughfare and west of the subsidiary waiting rooms is the concourse, a covered assembling place over 100 ft. wide, extending the entire width of the station and under the adjoining streets. An idea of the width of this concourse is gained by a comparison of it with the lobby of the Jersey City trainshed, which is narrower by 25 ft. This may be termed the vestibule to the tracks, as two sets of stairs descend from it to each of the train platforms on the track level. The concourse and adjacent areas are open to the tracks, forming a courtyard 340 ft. wide by 210 ft. broad, roofed by a lofty trainshed of iron and glass, similar in design to the famous trainsheds of the new stations in Frankfort and Dresden, Germany. In addition to the entrances to the concourse from the waiting room there are also direct approaches from 31st and 32d Sts. and Eighth Ave. The gates of the stairs descending from the concourse to the trains will bear signs announcing the name, destination and the time of departure of the train on the particular platform where the stairs land.

Auxiliary to the main concourse and located between it and the tracks is a sub-concourse, 60 ft. wide, which will be used for exit purposes only. This passageway is 18 ft. above the tracks,



Cross-Section Through Concourse of Pennsylvania Railroad Station.

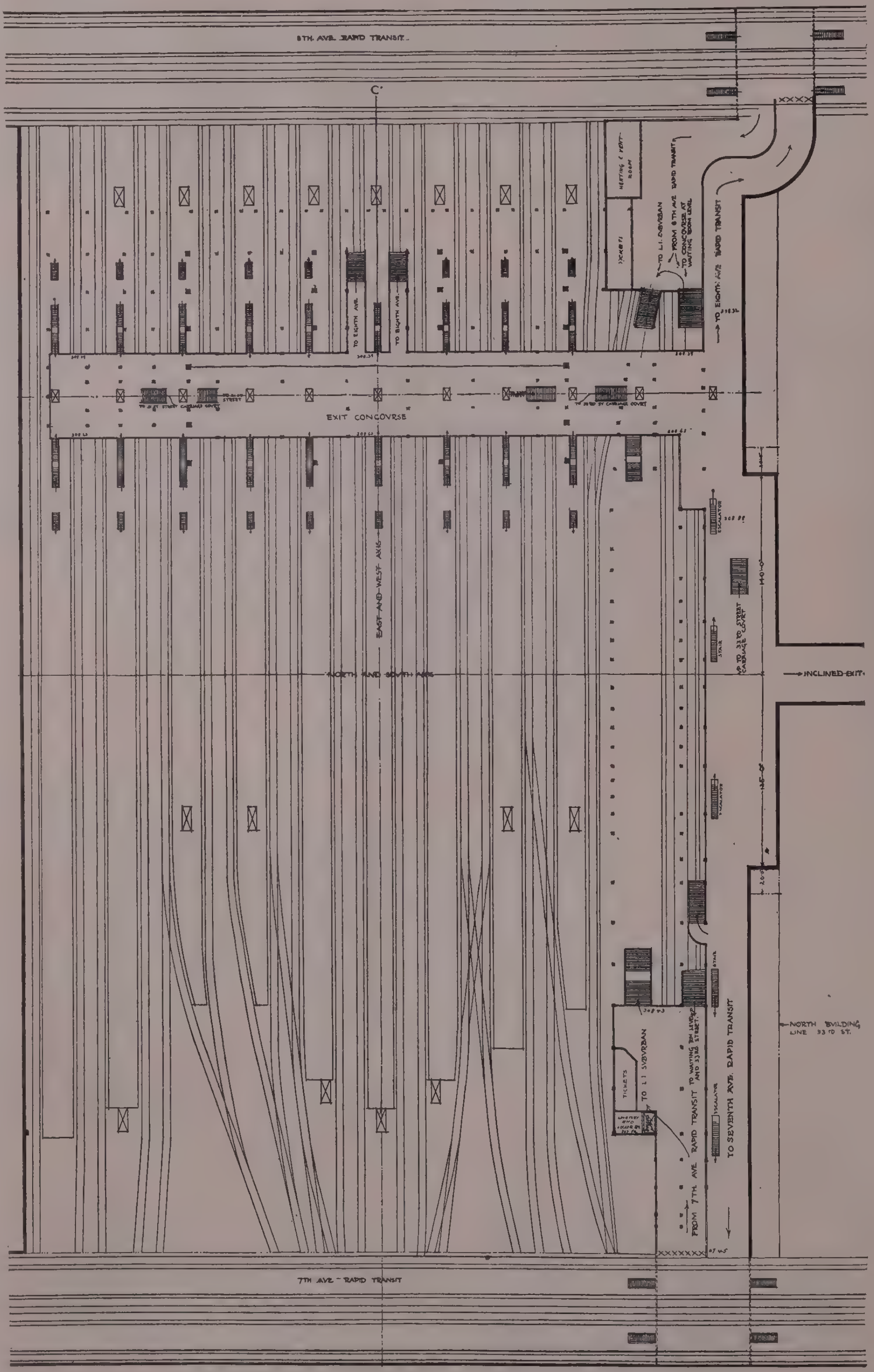
but is connected with the track level by two stairways and one elevator from each platform. From it ample staircases and inclines lead directly to 31st, 33d and 34th Sts., to Eighth Ave. and to future Rapid Transit stations under Seventh or Eighth Aves. Direct connection may also be made with the proposed subway stations on Herald Square without ascending to the street level.

The northern side of the station extending along 33d St. will be assigned to the suburban service of the Long Island R. R., into which trains will run from all points on Long Island by way of the East River tunnels. Ample entrances and exits are provided on Seventh and Eighth Aves. and 33d St., so that this traffic can be handled in connection with the adjacent subways and the surface lines on the surrounding streets independently of the rest of the station.

The third level, which is at a depth below the surface of the street corresponding to the height of a four-story building, is the track level. When the two tracks emerge from the tubes under the Hudson and reach the entrance to the station yards at Tenth Ave. they begin to multiply, and at Ninth Ave. and extending into the station the total number has grown to twenty-one. There is also a reduction in the number of tracks leading out of the station to the east, to a total of four for the main line, two passing under 32d St. and two under 33d St., and thence under the East River to the Long Island City yards. The track surface of the station may be compared to two unfolded fans joined together at the open ends, the handle of one extending under the Hudson and that of the other under the East River. Within the station area, covering 25 acres of ground space, there are 16 miles of tracks. This trackage area will afford ample facilities for easy movement of many hundred trains per day by the prompt and efficient means of electric power. Through trains from the western side of the Hudson, after discharging passengers, will proceed at once to Long Island City, where the train yards and terminals will be located, thus leaving the station tracks clear of any idle equipment, and likewise the west-bound through trains made up at the Long Island City terminal will pass through the station, stopping only to take up their quota of passengers. The suburban service of the Long Island Railroad will be operated on the shuttle plan, by which the trains are kept in continuous motion in and out of the station.

The planning of the station, with its numerous entrances and exits independent of each other and separating the incoming from the outgoing throng, was worked out to facilitate, in greatest measure, the prompt and uninterrupted movement of the traffic. The exposure of the building on all four of its sides to main arteries of street traffic gives the plan a flexibility which is rarely obtainable in a building of such enormous proportions situated in the heart of a great city, and also insures the making of easy connections by underground subways with the future extensions of the city's Rapid Transit system under Seventh and Eighth Aves. and the cross streets.

The designs for the station were made by Messrs. McKim, Meade & White, of New York, and will be executed under their direction.


8TH AVE. RAPID TRANSIT
C'
HEATING & VENT. ROOM
TICKETS
TO L.I. SUBURBAN
FROM 8TH AVE RAPID TRANSIT
TO CONCOURSE AT WAITING ROOM LEVEL
TO EIGHTH AVE. RAPID TRANSIT
TO EIGHTH AVE.
EXIT CONCOURSE
TO 31ST ST. CARRIAGE COURT
TO 33RD ST. CARRIAGE COURT
EAST AND WEST AXIS
NORTH AND SOUTH AXIS
TO 33RD STREET CARRIAGE COURT
INCLINED EXIT
STAIR
ESCALATOR
NORTH BUILDING LINE 33RD ST.
TICKETS
TO L I SUBURBAN
FROM 7TH AVE. RAPID TRANSIT TO WAITING RM LEVEL AND 33RD STREET
TO SEVENTH AVE. RAPID TRANSIT
7TH AVE. - RAPID TRANSIT

Plan at Exit Concourse Level, Pennsylvania Station.

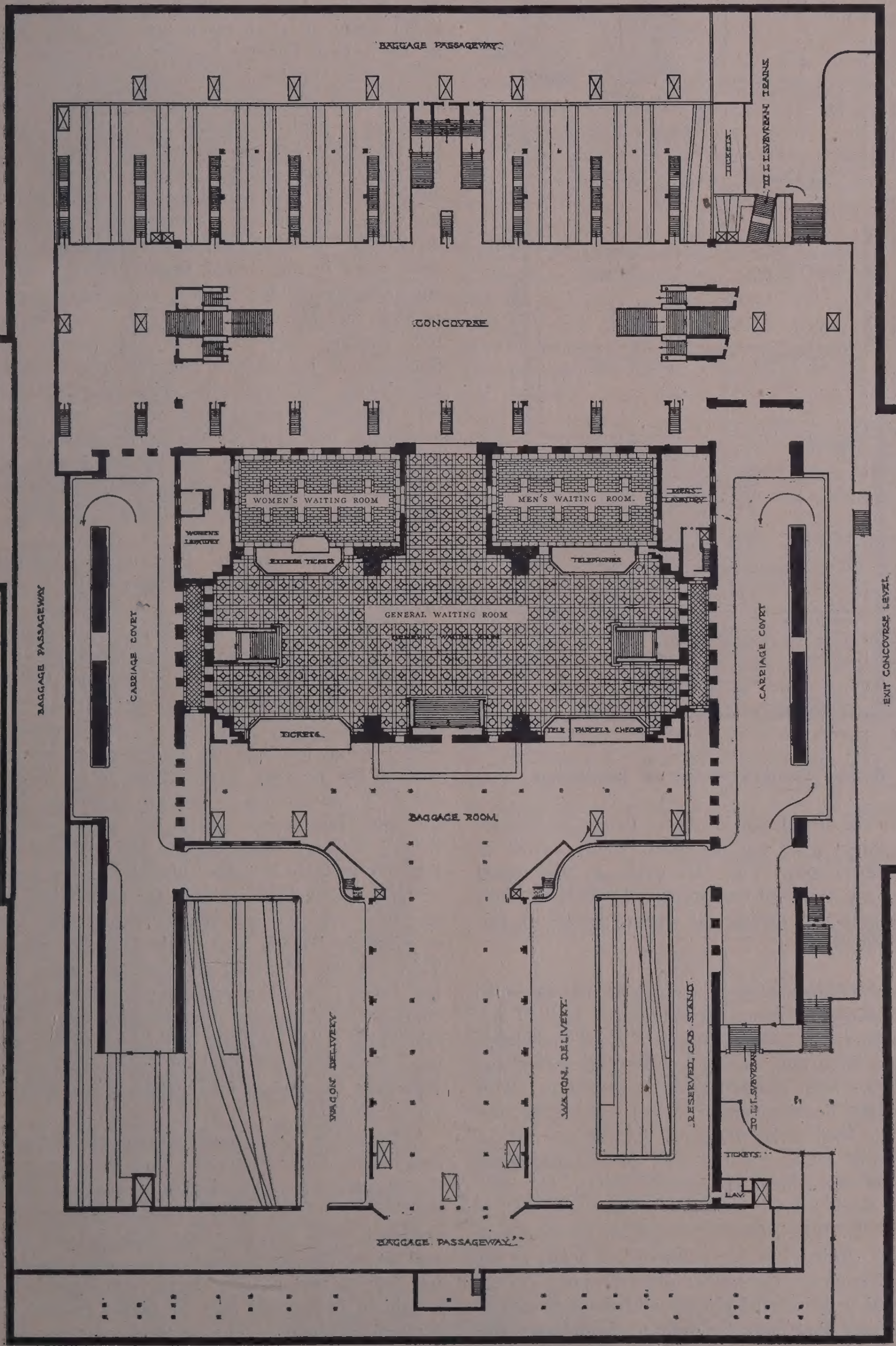
Wood Pavements in New York.

From the report of the Thoroughfares Committee, Wm. S. Crandall, chairman, of the Municipal Art Society of New York.

About three years ago a new form of pavement—that is, new to this country—was introduced into New York, known as wood block. It is made of rectangular blocks of Georgia or Florida pine first growth timber, and treated with a preparation which is said to add to its durability and make it sanitary. Although the sample laid had not given the fullest satisfaction to the abutting property owners, and while its durability was as yet undemonstrated, large contracts were awarded for some of the busiest downtown thoroughfares, such as lower Broadway, Chambers, Cortlandt and Liberty Sts. The pavement on Liberty and Cortlandt Sts. has been down for a year and a half, and the pavement on lower Broadway is just being laid.

The best thing that can be said about the pavement is that it is comparatively noiseless, but the fact that it is so slippery that on wet days in summer and snowy days in winter even an empty dray cannot make the grade on account of this slipperiness, is sufficient reason to condemn its extensive use, and in no case should it be used on even a light grade or where heavy trucking is done. Although the abutting property owners on Chambers St., where this pavement was laid last year, petitioned for it, some of them told your committee that they did not realize at the time that it was so slippery, and that despite the fact the noise is less on the street they would rather have the old block stone pavement, because it pleased the truckmen better.

This form of pavement was laid on the Williamsburg Bridge two years ago. A careful inspection of the driveway shows the present condition to be unsatisfactory in so far as its durability is concerned and its efficiency as a good pavement. Naturally the traffic on the bridge is exceedingly heavy and confined to narrow limitations, and for that reason it is not surprising that it is worn into ruts more or less pronounced. At intervals, on an average of about thirty feet, across the bridge, wide cracks between the blocks occur which is a defect not seen on streets and therefore may be due to the strain on the bridge. The assistant engineer said that whenever it rained bridge attendants were obliged to sprinkle the entire surface with sand in order to prevent horses from slipping down. The approaches to the bridge are laid with Medina stone which does not have to be sprinkled with sand at any time. Although the wood block is kept neat and clean, as compared with the plank roadway on Brooklyn Bridge, taking all things into consideration it is the judgment of your committee that for the sake of the lives of men and horses the plank roadway should be substituted for the wood block.



Plan at Waiting Room Level, Pennsylvania Station.

Replacing a Railroad Terminal Station.

An interesting part of the New York terminal improvements of the New York Central & Hudson River R. R., are the plans for handling the enormous passenger traffic without interference with train schedules while both tracks and buildings are removed and replaced by others in different positions. The difficulty of the problem can be inferred from the fact that the present 23-acre yard is being enlarged to 43 acres and depressed from 10 to 20 ft. to accommodate the express traffic, besides having a 20-acre yard excavated for a further depth of 22 ft. to provide for suburban traffic. This involves the excavation of 2½ million cubic yards of earth and rock, the erection of about 100,000 tons of steel and the laying of about 240,000 cu. yd. of concrete without interfering with about 1,300 daily train movements. Great quantities of old and new materials and spoil have to be handled for this purpose through the four-track tunnel which accommodates all the traffic, and the elaborate interlocking switch and signal systems must be constantly adjusted and extended to maintain unimpaired efficiency.

The present large terminal and office building is to be replaced by a new depot and train platforms about 700 ft. long and over 300 ft. wide. There has already been built a 200x200-ft., three-story temporary office building, and there are to be a 275x462-ft., 20-story permanent office building, a power house, express buildings, stores and offices occupying nearly all of two large city blocks. Most of the work is to be completed about five years from date.

The temporary office building, on the west side of the terminal, is now occupied by the company's engineering staff and by a branch of the United States Post Office. The south end of the tunnel has been rebuilt and additional tracks laid there, work is now in progress in excavating and widening the east side of the yard, and contracts have been awarded for erecting part of the permanent office building there.

The present scheme contemplates the erection at first of only the northern half of the office building, through the basement of which the trains will eventually run to and from the new terminal station. As soon as it is in readiness the basement will be used for a trainshed for a temporary east side terminal for the suburban traffic. The first floor of the Grand Central Palace, which now occupies the southern part of the site of the building, will be utilized as a waiting room for suburban service and the express traffic will be maintained in the westerly side of the high level present terminal station, while the yard construction is in progress on the intervening territory east of the center line of Park Ave.

The new terminal structure will then be completed up to, and temporarily roofed at, street level on the east side of the center line of Park Ave. While this part of the terminal structure is being built the express trains will also be run from the temporary east side terminal which will have been enlarged as above described. After the Grand Central building is completed all trains will enter it and the east side temporary terminal station will be used for storage and wash yard purposes. The street floor of the temporary office building at Madison Ave. and 43d and 44th Sts. will be utilized as a waiting room for a temporary west side terminal, and passenger communication will be provided by a ramp at the south end between it and the tracks. The sub-station of the post office will be removed to its permanent quarters in the new office building and excavation and yard construction will be completed on the west side of the center line of Park Ave.

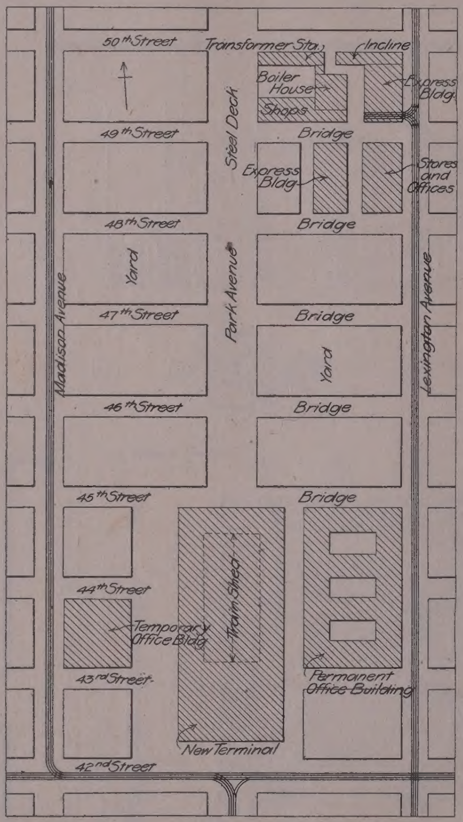
Finally the site of the office building will be cleared by the removal of the Grand Central Palace and the southern portion of the building will be constructed simultaneously with the construction of the remainder of the terminal building, which will be completed before the use of the temporary office building as a west side terminal is abandoned. This whole work is under the charge of Vice-President W. J. Wilgus.

Book Notes.

The latest addition to the Van Nostrand Science Series is "Shaft Governors" by Messrs. W. Trinks and C. Housum. The authors have been engaged for many years in designing and adjusting engines, and in this little book give the results of their investigations into a subject on which the printed information is of inconsiderable amount. The contents relate solely to what the authors term the statics of shaft governing and discuss in turn centrifugal moments, the centrifugal moment caused by the inertia of valves and valve gear, the mass of the valves reduced to the center of the eccentric, the reacting moment caused by the friction of the valves, the friction of the eccentric strap, the spring moment and the influence of the mass of helical governor springs. The detailed design of a governor for a Tod 42 and 76x60-in. tandem compound blowing engine running at 60 r.p.m. and a governor for a Buckeye 14½x24-in. engine running at 160 r.p.m. is then followed step by step. The book gives so much practical information hitherto unpublished that it deserves a wide circulation, although it is intentionally incomplete and such subjects as gravity balance, oscillations caused by gravity disturbances caused by too small rotating masses in the eccentric, synchronous oscillations of the spring, the influence of inertia masses, speed variations under change of load, and the effect of oil dash pots and friction brakes, are left for consideration in another book. (New York, D. Van Nostrand Co., 50 cents.)

Some time ago "Engineering News" and "Cement Age" joined in offering prizes for papers on the manufacture and use of concrete blocks. Both journals published the papers awarded prizes and extracts from others containing information not in the prize papers or furnishing the same information in greater detail. This information has been reprinted in a book of 122 octavo pages entitled "The Manufacture of Concrete Blocks and Their Use in Building Construction." The first prize was awarded to Mr. H. H. Rice whose elaborate volume entitled "Concrete Block Manufacture" was recently noticed in this journal. The second prize was given to a paper by Mr. Wm. M. Torrance, in which a considerable portion of the discussion related to the patents for machines and blocks. The information taken from other papers is classified under general heads and a good index to the entire book has been prepared. An examination of the pages shows clearly numerous important differences of opinion concerning the manufacture and use of concrete blocks. (New York, Engineering News Publishing Co., $1.50.)

The Bulletin of the U. S. Bureau of Labor for March contains an interesting report on the course of wholesale prices in 1890-1905. The salient features are summarized as follows: The 1905 average, compared with the year of lowest average prices during this sixteen-year period, in each of the general groups of commodities, shows farm products 58.6 per cent. higher than in 1896; food, 29.7 per cent. higher than in 1896; cloth and clothing, 22.9 per cent. higher than in 1897; fuel and lighting, 39.4 per cent. higher than in 1894; metals and implements, 41.8 per cent. higher than in 1898; lumber and building materials, 41.4 per cent. higher than in 1897; drugs and chemicals, 24.1 per cent. higher than in 1895; house furnishing goods, 21.5 per cent. higher than in 1897; and various miscellaneous articles, 23.4 per cent. higher than in 1896. Prices reached the highest point in December, 1905, when they were 19.9 per cent. above the average for the ten-year period 1890-99 and 33.7 per cent. above the low price in 1897. Prices in December, 1905, were 5.6 per cent. above prices in December, 1904. The data given in this report cover 259 series of quotations, of which 249 have been gathered during the entire period of sixteen years.



Grand Central Station Buildings.

Nobody can truthfully claim to be well informed concerning the general condition of applied science who has failed to acquire some knowledge of the important results in chemical technology that have been attained by electrical means. This industrial development is a very interesting one, but has been rather obscured for the general engineering reader by the lack of an elementary manual furnishing an introduction to the subject. Such a book is now available, however, in Dr. F. G. Wiechmann's "Notes on Electrochemistry." Indeed, in his endeavor to begin at the very beginning, the author gives chapters on the general principles of physics and the elements of electricity that may be omitted from later editions without detriment to the book. The chapters on electrochemistry, electrolytic dissociation and electro-analysis furnish the class of information most useful in affording a proper understanding of the subject as a whole. The final chapter, on electrotechnology, gives a general survey of what electricity is accomplishing in chemical fields, and the reader will find the record as interesting for its promise of future advances as well as present achievements. The author points out that exact data of technical operations are often very difficult to procure, and therefore the figures given, while well indicating the general conditions, cannot claim in all cases to be actual working formulas. (New York, McGraw Publishing Co., $2.00.)

A great many of the statements made by Mr. J. W. Thomas, in his "Ventilation, Heating and Lighting of Dwellings" are wholly at variance with the theory and practice of such work in this country. For example he says that the best temperature for sitting rooms is 62° to 63° F.; this may be true in Great Britain, but it is certainly not correct on this side of the Atlantic. Again, he states that experience has shown that in dwelling houses in England it is most unwise, with hot water warming, to allow spare boiler room, so as to make sure that there shall be more than enough heating power when the temperature outside is below freezing point. Although such statements occur so frequently that the book is likely to mislead an American reader not previously acquainted with the details of our heating systems and the reasons for them, the expert will be well repaid for an examination of the volume by the many controversial arguments it contains. Heating dwellings in England and the same work in the United States are very different undertakings for climatic and temperamental reasons, and Mr. Thomas's advice is for the former country only. Moreover he speaks very dogmatically on disputed subjects and a reader not already well acquainted with current American practice might gather wrong impressions concerning the state of the art in consequence. The specialist in heating and lighting houses will find the book very interesting reading, however. (New York, Longmans, Green & Co., $2.00.)

MODERN ENGINEERING PRACTICE. Editor-in-Chief, Frank W. Gunsaulus, assisted by a corps of Distinguished Engineers and Technical Experts. Chicago, American School of Correspondence; 12 vols., large 8vo., half morocco, $60.

These useful manuals embody the practical result of an earnest endeavor to present the principles of numerous branches of engineering in such a form that they can be readily understood without the personal explanations of an instructor in a class-room. They are compiled from the best instruction papers of the American School of Correspondence, and will be found particularly valuable in school libraries, in the homes of boys showing an aptitude for mechanical and electrical subjects, and for mechanics who wish to grasp the leading facts of the branches treated. They are not advanced treatises, and great care was taken to avoid giving them anything of that character. Advanced mathematics are wholly eliminated. An excellent statement of the purpose of the books is given in the introduction by President Gunsaulus, from which a few extracts are given here:

"One of the things most unfortunate to the development of our American resources, or to the development of engineering as a science, or to the man who has been under a misapprehension with regard to how much or how little he can know and do in the world, is the fact that engineering science and practice have been regarded as a field to be entered only by highly trained and favored students. The current opinion of a few years ago, that a man without certain technical information, difficult to obtain, could be nothing but a hired hand, has done vast harm. The miracle of our time is found in how near to a firm purpose and a clear head, knowledge may be brought,—not the knowledge of the street but that knowledge which has hitherto been sacredly or unsacredly guarded as a possession of professional scholars alone. These pages are the apparatus of teaching, and they have proved, in thousands of cases, to be understandable by those who have not had the opportunity of attending engineering schools. They have been written with the idea that many a man who otherwise would remain a day laborer all his life shall begin with their use the career of a scholar. Anybody who has a new idea which is true and a new mastery of forces of nature, however little it may be, has entered the career of a scholar."

It is impossible within the limits available for book reviews in this journal to present a critical notice of the contents of each volume. The grouping of the subjects is as follows: Volume 1, elements of electricity, the electric current, electrical measurements, electric wiring, the electric telegraph, wireless telegraphy, the telautograph, insulators, electric welding. Volume 2, the theory of dynamo-electric machinery, direct-current dynamos, types of dynamo-electric machinery, direct-current motors, electric motors in machine shop service, storage batteries, automobiles. Volume 3, the management of dynamo-electric machinery, inspection and testing, localization and remedy of troubles, power stations, a quarter-century of American central station engineering, electric lighting, shop lighting, electric railways. Volume 4, the alternator, commercial types of alternators, synchronous motors, the transformer, the rotary converter, the induction motor, switchboard and station appliances, power transmission, the mercury vapor converter. Volume 5, telephone instruments, telephone lines, telephone exchanges, common battery systems, telephone operation, telephone systems, telephone maintenance, automatic telephone, wireless telephony. Volume 6, principles of heat, chemistry, construction of boilers, types of boilers, boiler accessories, calorimeters, steam pumps, steam valves. Volume 7, the steam engine, steam engine indicators, valve gears, thermodynamics, the steam turbine, refrigeration, ammonia compression system, absorption system, gas and oil engines. Volume 8, marine boilers, boiler stays, marine engines, condensers, navigation, locomotive boilers and engines, valve motions, types of locomotives, the air brake. Volume 9, pattern making, patterns from drawings, simple patterns, machine design, general drawing, metallurgy, foundry work, loam moulding, steel castings, brass work, shop management. Volume 10, machine shop work, the lathe, the planer, the shaper, the milling machine, the grinding machine, tool making, hardening, thread-cutting dies, drill jigs, forging. Volume 11, drawing instruments and materials, geometrical definitions, projections, working drawings, machine drawings, working shop droppings, perspective drawing, rendering in pen and ink, architectural lettering. Volume 12, systems of warming, principles of ventilation, furnace heating, steam heating, hot-water heating, plumbing fixtures, sewerage, water supply, carpentry. The last volume also contains a voluminous index, and each of them has a collection of review questions to test the reader's knowledge of the subjects he has been studying.

These volumes give the substance of instructive papers which have proved valuable to thousands of correspondence students, which is not surprising when the list of their writers and collaborators is considered. Apart from the teaching staff of the Armour Institute of Technology, many eminent professors have taken part, Prof. F. B. Crocker, of Columbia University, Prof. William Esty, of Lehigh University, President Victor C. Alderson, of the Colorado School of Mines, Prof. D. C. Jackson, of the University of Wisconsin, Prof. L. S. Marks, of Harvard University, and many others. The list of men engaged in practical work who were associated with the production of the volumes includes, among others, such names as Mr. Charles L. Griffin, mechanical engineer of the Semet-Solvay Co., Mr. Ralph H. Sweetser, superintendent of the Algoma Steel Co., Mr. Frank Chouteau Brown, the Boston architect, and Mr. Kempster B. Miller, the well-known telephone specialist. The contents of the several volumes differ somewhat in quality, for all of the writers have not been equally successful in estimating the attainments which the average correspondence student possesses. Nevertheless the editorial work has been done so well that the result is surprisingly good and will be found valuable to a wide circle of readers who do not care for the more elaborate treatises of specialists.

Letters to the Editor.

The Reinforced-concrete Buildings at Stanford University.

Sir: We note with interest the article by Prof. Marks in your issue of May 13th, on the effect of the earthquake at Stanford University, California, but were greatly surprised to observe that Prof. Marks should have made statements to the effect that the walls of Roble Hall and the concrete portion of the Museum Building were not reinforced. It is evident that Prof. Marks made his statement without careful investigation to the effect that the walls of Roble Hall and the that the chimneys of Roble Hall were not reinforced, which chimneys, as Prof. Marks states, were built after the building was finished and were not installed by the contractors of the original building. You will note that Prof. Marks states that the rods for these chimneys were delivered at the University, but were not used, and it appears to us that he might have drawn a natural inference that similar rods were placed in the walls.

As a matter of fact the walls in both Roble Hall and the Museum are heavily reinforced, which fact very largely nullifies Prof. Marks' statement and conclusion that brick walls laid in good cement mortar can be laid as monolithically as cement walls, and that the latter will not need steel to resist shock. Both of these buildings, Roble Hall and the concrete portion of the Museum Building, were built by us, so that we are speaking from first-hand knowledge and we would suggest that if Prof. Marks makes a careful investigation he will find the facts as stated.

Yours truly,

Ransome & Smith Co.

New York, May 15.

A Discussion of Reinforced-concrete Beam Formulas.

Sir: The recent article by Mr. Wason before the American Society of Civil Engineers as reported in your issue of May 5th, has attracted my attention, and I wish to lay before you the results of a similar investigation of mine along the same lines. The purpose of this investigation was to compare in a practical manner the various existing formulas for concrete-steel beams. The questions of shear and slipping of the steel in the concrete were not regarded, the location of the neutral axis and the resisting moment of the section being the point upon which the comparisons are made.

The first step was the compiling of existing formulas, reduced to their simplest terms and expressed in the same symbols. These are classified according to the assumptions made regarding the distribution of compressive stresses, etc.

The following is the list of symbols: b = breadth of beam; k = depth of beam; d = depth to centre of steel; y_1 = distance from top of beam to neutral axis; y_2 = distance from neutral axis to centre of steel; E_s = modulus of elasticity of steel in tension; E_c = modulus of elasticity of concrete in compression; E'_c = modulus of elasticity of concrete intension; C = maximum allowable unit compression on outermost fibre of concrete; T = maximum unit stress in steel; S = area of steel reinforcement; p = ratio of steel to area of concrete above steel; $P = 100\ p$; M_o = moment of resistance in inch-pounds.

Formulas which assume that the steel carries all of the tensile stresses.

Thacher: Stress curve of compressive stresses a straight line.

$$y_1 \cdot \sqrt{\frac{ZedoS}{b}+\left(\frac{eS}{b}\right)^2}-\left(\frac{eS}{b}\right) \qquad e=\frac{Es}{Ec}$$

$$M_o=\frac{12T}{36}\left(\frac{y_1^3}{e\,y_2}+3\,S\,y_2\right)$$

Sewall: Stress curve a compromise between a straight line and a parabola.

$$M_o = 0.85\ d\ S\ T.$$

Buel: Stress curve a straight line.

$$y_1=-\frac{Se}{b}+\sqrt{\frac{2\,Sed}{b}+\left(\frac{Se}{b}\right)^2}$$

$$M_o = I_c\ C/y_1\ c$$

$$I_c = b\ y_1^3/3 \qquad I_s = S\ y_2^2$$

$$c/s = q = I_c/eI_s$$

c = proportion of load sustained by concrete.
s = proportion of load sustained by steel.

Von Emperger's: Compressive and tensile stresses uniformly distributed over their respective sections.

$$M_o = W\ C_s\ T.$$

$$W = bd^2/6 \qquad p = S/bd$$

$$C_s = 3\ p\ [2 + 15\ p - \sqrt{15\ p\ (15\ p + 2)}]$$

Wentworth: Stress curve a straight line.

$$y_1 = r\ S/6 \qquad r = T/C.$$

$$M_o = 6\ C\ y_1\ (d - \tfrac{1}{3}\ y_1)$$

Hennebique: Compressive stresses uniform over compressed area—moments of tensile and compressive stresses about neutral axis equal.

$$y_1 = y_2 = \tfrac{1}{2}\ d.$$

$$M_o = C\ b\ y_1^2 = 2\ S\ T\ y_1.$$

Prof. Church: Stress curve a straight line.

$$y_1=-\frac{Se}{b}+\frac{Se}{b}\sqrt{\frac{2\,bd}{Se}+1}$$

$$M_o = \tfrac{1}{2}\ C\ b\ y_1\ [d - \tfrac{1}{3}\ y_1]$$

$$= S\ T\ [d - \tfrac{1}{3}\ y_1]$$

Prussian Government: Same assumption and same formulas.

Slocum: Stress curve a straight line.

$$y_1^2 = y_2^2\ e \qquad y_1 + y_2 = d.$$

$$M=\frac{C\,I}{y_1} - I=\frac{1}{12}\,bd^3$$

Farrar: Stress curve a straight line.
When $E_s = 29{,}000{,}000$

$$y_1 = \left[\frac{290{,}000}{290{,}000 + 54\,T}\right] d$$

$M_c = 170\,b\,y^2$

$M_o = M_c + S\,T.\,y_2$

Sabin: Stress curve a straight line.
T^1 = stress actually sustained per square inch in steel.

$$y_2 = (T^1/C)\ (y_1/e).$$

$$S = 2/3. \qquad C/T^1\,y_1 = 2/3\,C\,y_1/T^1$$

$$M_o = b.\,C.\,(5/12 + 2/3\,T^1/Ce)\,y_1^2.$$

This is the formula which Mr. Sabin uses when the modulus of elasticity of the concrete varies widely during the loading as is the case with excessive reinforcement.

Goldmark: Stress curve a straight line.

$X = y_1/d \quad x = \sqrt{4/5\,e\,p\,(4/5\,ep + 2)} - 4/5\,ep$

$M_o = 5/8\,C\,bd^2\,(1 - 2/5\,x) = p\,T\,bd^2\,(1 - 2/5\,x)$

$$p = S/bd = (5\,I/8C)\ (1 + T/Ce)$$

$$I/c = e\ (1 - x)/x.$$

Prof. Talbot: Derived from tests.

$$M_o = S\,T\ (0.906 - 6.5\,p)\,d.$$

Condron: Purely empirical.

M_o — (plain bars) = $(275\,P + 55)\ bd^2$.

— (corrugated bars) = $(450\,P + 55)\ bd^2$.

Taylor & Thompson: Stress curve a straight line.

$$X = ep\ (\sqrt{1 + 2/ep} - 1).$$

$M_o = p\,T\,bd^2\,(1 - x/3) = 1/2\,Cx\,bd^2\,(1 - 1/3)$

Prof. Burr: Stress curve a straight line.

$$y_1 = -\frac{eS}{b} + \sqrt{\left(\frac{eS}{b}\right)^2 + 2e.\,\frac{S}{b}.\,d.}$$

$$M_o = C\ (1/3\,b\,y_1^2 + (e/y_1)\,S\,y_2^2).$$

$$T = .(e/y_1)\ y_2\,C.$$

Wason:

$$M = 2/3\ d\,S\,T.$$

For every square inch of steel he provides 32 sq. in. of concrete in the upper third of the beam.

Formulas which assume that the concrete carries part of the tensile stresses.

Considere: Straight line distribution of stresses in concrete above neutral axis; uniform distribution in concrete below neutral axis.

$hx = y_1. \qquad hu = d.$

$C = (T/e)\ (1 - x) \div (x - u)$ where t = unit tensile stress.

$tx + Tp = (T/2e)\ (T - x)^2 \div (x - u)$ in concrete.

$M_o = bh^2\ (1/6\,tx\ (4 - x) + 1/3\,Tp\ (x - 3u + 2)\ ).$

Johnson: Stress curve a parabola.

$y_1 = d\ (E_s - l_c) \div (T + E_s\,l_o).$

$l_c = l'_c\ (1 - \sqrt{1 - 8C'/9C}).$

C = ultimate strength of concrete.

$r = l_o/l'_c.$

$l'_c = 9\,C/4\,E_c.$

$z = (4 - r)\ y_1 \div (12 - 4\,r).$

$G = E_c\,l_t\,2/2\,l_c.$

$t = 0.00015.$

$M_o = pbd\,T\ (d - z) + by_1\,G\ (y_1 + 2/3\,y_1\,l_t/l_c - z).$

Hatt: Distribution of both tensile and compressive stresses given by a parabola with axis horizontal and origin on curve.

Approximate straight line formula for 1:2:4 concrete.

$M_o = Ktbh^2.$

$K = [1/3 + (7/4\,u - 1)\,P].$

For the purpose of comparison of the formulas it does not matter what values are assigned to the different constants so long as the same constants be used throughout the whole comparison. In this case, however, constants were used which were derived from the most conservative practice of to-day, as embodied in the building laws of different cities and the reports of different engineers.

The following values were assumed:

$E_s/E_c = e = 12$: $C = 500$ lb. per square inch; $T = 16{,}000$ lb. per square inch; $t = 150$ lb. per square inch; $c' = 2{,}000$ lb. per square inch; $b = 12$ in.; $d = 16$ in.; $h = 18$ in.

Five beams were reviewed, all 12 in. in breadth, 18 in. in depth with the steel 16 in. below the upper surface. Five different percentages of steel were considered, .0104, .0093, .0083, .0073 and .0063 and the different resisting moments computed. The results are given in the accompanying table.

These formulas exhibit a wide range of results but the remarkable and significant fact disclosed by this investigation is that five formulas give results that agree very closely. In the case of Beam No. 3 which exhibits the widest range of results among these five formulas, the greatest variation among them may be stated as 2½ per cent.

COMPARISON OF THE RESULTS GIVEN FOR IDENTICAL CONDITIONS BY TWENTY FORMULAS FOR REINFORCED CONCRETE BEAMS.

Beam Steel Formulas.	Beam No. 1 p=.0104		Beam No. 2 p=.0093		Beam No. 3 p=.0083		Beam No. 4 p=.0073		Beam No. 5 p=.0063	
	y_1	M_o	y_1	M_o	y_1	M_o	y_1	M_o	y_1	M_o
Sabin	12	552,000	11.7	533,400	11.4	522.000	11.1	517,200	10.7	508.200
Hatt		518,400		489,900		454,900		425,700		390,800
Hennebique		512,000		460,800		409,600		358,400		307,200
Johnson	4.56	469,500	4.56	423,200	4.56	382,900	4.56	336,700	4.56	296,400
Condron		450,600		421,900		380,900		339,900		298,900
Goldmark		440,300		393,200		358,800		314,600		275,300
Sewall		435,200		393,500		349,800		306,000		262,300
Talbot		430,600		389,100		348,200		307,200		266,200
Farrar	4.0	416,600	4.0	378,200	4.0	339,800	4.0	301,400	4.0	263,000
Wentworth	10.67	401,100	9.6	368,600	8.6	340,600	7.4	301,900	6.4	266,900
Von Emperger		393,300		352,200		311,300		278,500		245,700
Considere		348,400		343,600		336,700		329,900		323,000
Wason		341,100		307,200		270,000		238,100		204,800
Slocum	6.1	341,400	Contains no factor depending on S.							
Thacher	6.24	322,600	6.0	297,600	5.73	270,400	5.42	243,800	5.11	214,400
Prof. Burr	6.24	261,000	6.0	252,000	5.73	238,900	5.42	226,900	5.11	218,400
Buel	6.24	260,400	6.0	252,600	5.73	242,500	5.42	230,800	5.11	222,300
Taylor & Thompson		258,600		248,800		236,500		227,300		218,900
Prof. Church	6.2	258,600	5.97	250,900	5.72	242,000	5.43	231,200	5.11	219,200
Prussian Government	6.2	258,600	5.97	250,900	5.72	242,000	5.43	231,200	5.11	219,200

Whatever discussion is brought forth in defense of the formulas giving the higher values to M_o, certainly the agreement of these five formulas is more than a mere coincidence. In the present maze of theory and with the ever-present uncertain factor of poor workmanship, it is highly advisable to use a conservative formula. Refinement in the design of concrete beams is absurd if carried very far.

These formulas have been compared within the limits of safe working stresses and with no reference to the ultimate strength. It is the consensus of opinion among engineers that the safest procedure is to embody the factor of safety in the unit stresses instead of designing a beam on the basis of its ultimate strength.

These five formulas Prof. Church's, Prof. Burr's, Buel's, Taylor & Thompson's and the Prussian Government's, agree quite closely in the location of the neutral axis. They seem more reasonable than some of the other formulas in that the location of the neutral axis is dependent upon the amount of steel reinforcement.

Very truly yours,
CHARLES E. CUTLER.

Ithaca, May 9.

HEATING THE UNIVERSITY OF PENNSYLVANIA DORMITORIES.

SIR: In Prof. Henry W. Spangler's paper on the heating of the Edgar F. Smith dormitory of the University of Pennsylvania, a report of which appears in your issue of May 12, reference is made to the second lot of dormitories built for the University in 1900 and the apparatus there is described as direct radiation "with an auxiliary fan system for use in very cold weather." This is a curious mis-statement, and as I designed the apparatus referred to, perhaps I may be allowed to make a correction. This fan system was never intended for heating (though incidentally some slight help in heating was expected from it), nor was it for use in very cold weather only; but it was installed for the purpose of supplying fresh air at a temperature of about 70° to the various rooms, more especially during the recognized study hours, and was, in my judgment, a better and more economical solution of that particular problem than an "indirect" system would have been. Modern practice, for obvious reasons, is somewhat opposed to the use of direct radiation alone, even in an ordinary dwelling house, and it is possible that when the desirability of an ample supply of fresh air and its relation to the efficiency as well as to the comfort and health of the student are better understood and appreciated at the University of Pennsylvania, the "discontinued" fan system may be called upon to perform its proper function.

Yours truly,
PERCY N. KENWAY.

THE SYSTEM OF REGULATION used in the gas engine designed by Mr. A. Mees, of Dusseldorf, is arranged to draw in at normal loads a relatively weak mixture which is sufficiently compressed and is readily ignited, while at maximum load a richer mixture is drawn in. The system is a combination of the mixture process, where the mixture ratio of the charge of gas and air is altered, with the charge process, where the amount of the charge itself is altered. This system maintains the advantages of both while eliminating their inconveniences. With low loads the motor draws in charges of normal composition and of varying amounts, compressing each charge more or less according to the load, but in any case much more than in any motor regulated exclusively by the charge process. The admission valve, the vital feature of the engine, is combined with a piston slide having ports, either rectangular, triangular or of other shape, cut in it, and this slide either closes corresponding ports in the valve box or graduates the amount of opening given to them. Tests of nine hours duration have shown for an output of 21.66 electrical horse-power an average consumption of anthracite coal of 0.382 kg. per electrical horse-power-hour at about 75 per cent. of the maximum load.